GEOGRAPHY KENTUCKY KNOBS

WILBUR GREELEY BURROUGHS

The

Kentucky Geological Survey

WILLARD ROUSE JILLSON
DIRECTOR and STATE GEOLOGIST

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Geography of the Kentucky Knobs

1926

PLATE I. WEST PINNACLE OF THE KNOBS

Looking west from Indian Fort Mountain, Madison County, the knob, West Pinnacle, is in the center of the picture, with the Lexington peneplain beyond. The corn field is on Waverly formations, which are overlain by Mammoth Cave limestone topped with Pottsville conglomerate. Ohio shale forms the bedrock from the knobs to about one mile beyond the houses seen in the distance, when Devonian limestone and Silurian strata come to the surface.

The GEOGRAPHY *of the* KENTUCKY KNOBS

A Study of the Influence of Geology and Physiography upon the Industry, Commerce and Life of the People.

BY

WILBUR GREELEY BURROUGHS

ASSISTANT GEOLOGIST

Illustrated with Fifty-five Photographs, Maps and Diagrams

FIRST EDITION
1000 COPIES

THE KENTUCKY GEOLOGICAL SURVEY
FRANKFORT, KY.
1926

To My Parents
Who
From My Youth
Taught Me the Science of the Earth
This Book is Dedicated.

Contents

Letter of Transmission

Dr. Willard Rouse Jillson,

Director and State Geologist,
The Kentucky Geological Survey,

Frankfort, Kentucky.

Dear Sir:

Permit me to transmit herewith my manuscript and illustrations of a report on the "Geography of the Kentucky Knobs."

This bulletin is the result of three years of geologic and geographic work in the Knobs and other physiographyic divisions of Kentucky. Intensive field investigations were carried on for the Kentucky Geological Survey during 1922 and 1923. Photographs, with but few exceptions, were taken by the author.

Throughout this report the author has described the natural resources of the Knobs. The development, both present and future, of these natural resources is discussed fully. The influence of geology and geography upon life, industry, and commerce has been emphasized.

The "Geography of the Kentucky Knobs," has been written so that it can be of value to all those interested in the development of Kentucky. It also can be used as a textbook, or for collateral reading in the public schools, especially of the Knob counties. The youth of Kentucky should know of the opportunities afforded them in their own home regions.

The author acknowledges the helpful co-operation of Dr. W. R. Jillson, Director and State Geologist of the Kentucky Geological Survey. Mrs. Mavis Reynolds Burroughs rendered valuable aid in the preparation of the manuscript, and in exploring and surveying the Indian Fort. Professor Samuel Mayfield gave assistance in exploring the Fort. Citizens of Kentucky

who cooperated in any way are given credit at the appropriate places in the report.

It is the author's sincere desire that this bulletin may be of value, economically and socially, to the people of the Knobs and to the State.

Respectfully submitted,

Wilbur Greeley Burroughs,

Assistant Geologist.

Berea, Kentucky,
July 5, 1923.

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Geography of the Kentucky Knobs

CHAPTER I.

GEOGRAPHIC CONDITIONS

Kentucky is divided into seven physiographic regions the names and positions of which are as follows:

1. The Bluegrass—central northern.
2. The Knobs—central crescentic.
3. The Kentucky Mountains—eastern.
4. The Mississippian Plateau—central and southern.
5. The Western Coal Field—western northern.
6. The Jackson Purchase—southwestern.
7. The Ohio River Lowlands.

The Knobs

Space Relationship

The Knobs of Kentucky are a belt of conical hills and detached ridges* with a narrow strip of rolling land forming their inner margin, which extend in the form of a horseshoe from Vanceburg on the Ohio River in Lewis County south and southwestward through the counties of Fleming, Rowan, Bath, Montgomery, Clark, Powell, Estill, Madison, Rockcastle, Garrard, and west and north through Lincoln, Boyle, Marion, Nelson, Bullitt, Jefferson, ending in the northern portion of Oldham County. The total distance is approximately 233 miles. The distance between the most northerly ends of the Knob Belt in Lewis and Oldham counties is about 103 miles. The total area of the Knobs proper is approximately 2,218 square miles. Estimater vary, depending upon the distance the Knobs are considered to extend in to the Mississippian and Pennsylvanian Systems of the physiographic divisions bordering the Knob belt. The latitude, longitude and elevation above sea level for points throughout the Knobs are given in Tables Nos. 1 and 2.

*Because of their individual rugged figure these hills are frequently referred to as "mountains."

Within the horseshoe formed by the Knobs lies the Bluegrass; outside of the curve on the east the Knobs, in places, meet the "Mountains" of Eastern Kentucky; on the northeast, south and west they grade into the Mississippian Plateau; along the northern extremities Quaternary and Recent deposits form a narrow strip between the Knobs and the Ohio River.

Adjacent to the Knob Belt, in the counties of Casey, Taylor, Larue and Hardin, there have been exposed along a few stream valleys narrow strips of the same formations as those composing the main Knob area. But these outcrops are comparatively limited, they are not bounded by the Bluegrass, and therefore cannot be included in the typical Knob Region of Kentucky. Still further south, rivers have exposed similar strata in the counties of Pulaski, Russell, Wayne, Clinton, Cumberland, Monroe, Allen and Barren, but for the reasons stated, these counties also do not form part of the true Knobs. Silurian strata occur at the surface in Trimble County and stretch a short distance into Carroll County; and small areas of the Silurian extend from the main Knob Belt into a few of the bordering Bluegrass counties, but these districts do not include the other Knob formations and hence are not counted as Knob territory.

The counties through which the Knob Belt proper passes are not entirely Knob land. They also include other physiographic divisions, as is shown on the accompanying geologic map, Plate II. The Knobs are made accessible by railroads and the Ohio and Kentucky rivers which are navigable.

Physiography

The Knobs are drained by several large river systems. The Ohio River which is separated from the northern ends of the Knobs by a narrow strip of Quaternary and Recent deposits as shown in Plate III, forms the base-level into which the larger rivers of the Knobs flow. South of Vanceburg on the Ohio River, Lewis County, occurs a divide extending northwest-southeast that separates the northward drainage, such as Salt Lick which flows directly into the Ohio River, from streams emptying into the Licking River. The Licking, which heads

PLATE II. MAP OF KENTUCKY SHOWING THE KNOBS REGION

A belt of dissected, surficial Mississippian strata occurs east of the stippled area in Lewis County and to the Kentucky Mountains in Rowan and counties southward. In Trimble County the stippled area is entirely Silurian strata.

in the Eastern Kentucky Mountains, flows northwestward and empties into the Ohio at Covington. It passes through the Knobs where the boundaries of Rowan, Fleming and Bath join. The southern side of the Licking drainage area in the Knobs, occurs in Montgomery County. Beyond this divide to the south the Kentucky River drainage system begins and extends until the watershed between the Kentucky and Salt Rivers is reached in Boyle and Casey counties. The Kentucky River rises in the Mountains of Eastern Kentucky and cuts the Knobs in the vicinity of Irvine, Estill County, Plate IV, in a meandering northwesterly direction, continuing across the Bluegrass to empty into the Ohio River at Carrollton, Carroll County. The Red River empties into the Kentucky River a short distance before the latter stream leaves the Knobs for the Bluegrass. The Dix River and its tributaries erode the Knobs in Garrard, Lincoln and Boyle counties; and flowing northward empties into the Kentucky River near High Bridge. On the western side of the Knob Belt, Rolling Fork flows northwest from the southern Knobs and empties into Salt River near where the counties of Larue, Nelson and Hardin meet. These rivers and their tributaries form the drainage system of the southwestern and western Knobs. Salt River enters the Ohio River at West Point, Bullitt County. North of this drainage basin, in northern Jefferson and Oldham counties the smaller streams flow directly into the Ohio River.

The creeks in the rougher knobs, especially, rise at a comparatively high elevation and rapidly descend until the larger rivers, such as the Kentucky, are reached. In the knobs the creeks carve deep, narrow valleys. Since these streams are deepening their channels they do not have extensive bottom land along their courses in the rougher areas.

Rivers have strikingly affected the development of the Knobs, Mountains and Plateaus of Kentucky by eroding gateways through the otherwise almost impassible barrier of the escarpment which the Cumberland Plateau presents to the Bluegrass. Railroads have entered by these gaps and following the river valleys have penetrated and opened up the mountains.

The railroad leading from Irvine to Beattyville is laid along the narrow flood plain of the Kentucky River which it follows in all of its meanders. Passes have also been formed by streams lowering the knobs as at Boone's Gap, Plate V. The people

PLATE III. THE NORTHWESTERN EDGE OF THE KNOBS.
Looking northward near the boundary of Jefferson and Oldham counties. Knob land is seen on the right sloping down to the plain of Recent deposits which border the Ohio River.

of eastern Kentucky owe a debt of gratitude to the rivers, without which the railroads could not have passed through the Knobs into the Mountains, bringing prosperity to the owners of timber and coal land.

The valleys between the knobs are utilized to shorten railroad lines. The Louisville & Nashville Railroad passes from Jefferson to Bullitt County between the knobs of South Park Hill and Norton Hill and the high land to the west, thereby saving several miles. Further south, the railroad goes through a narrow gorge cut between Coleman Knob and MacDonald Knob, Bullitt County.

In the Knobs, the Kentucky River, due to a system of dams and locks, is navigable to Beattyville and a short distance beyond. The Ohio River affords an opportunity for transportation by water of products from the nearby Knobs.

The valleys and divides of the smaller streams in the Knobs control the location of wagon roads; and in the wilder, rougher sections the trails follow the edges of the creeks and in places

wind along the stream bed itself. Streams serve as water power for small grist and sawmills. They are used for drinking purposes by both man and animal.

Towns have been built upon river terraces and flood plains. Irvine, Estill County, is situated upon a terrace formed by the

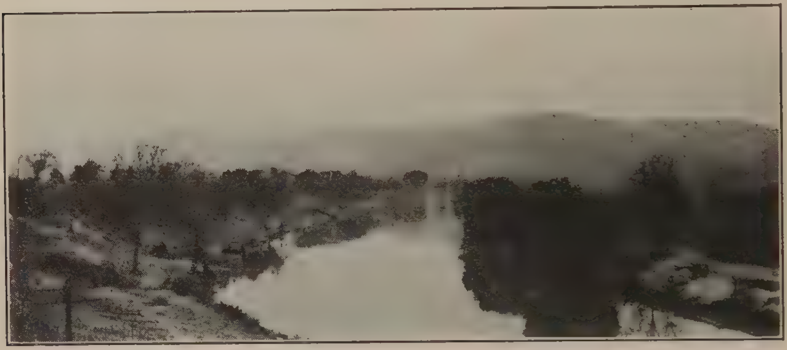

PLATE IV. THE KENTUCKY RIVER CUTTING THROUGH THE KNOBS.

View at Irvine, Estill County, looking eastward, upstream. The lower of the two river terraces seen on the right. Irvine is situated on the higher terrace.

Kentucky River. Clay City, Powell County, is located on the floodplain of the Red River. Vanceburg, Lewis County, is on the south shore of the Ohio River. Louisville, which spreads over onto Knob formations, is at the Falls of the Ohio.

Rivers, as shown on the geological map of Kentucky, are often used as boundaries between Knob counties. Near the region under discussion, the north shore of the Ohio River is the dividing line between Ohio and Kentucky.

The topography of the Knobs which are adjacent to the Bluegrass, is that of gently sloping hills and ridges with flat bottom land one-quarter of a mile wide and more, bordering the larger creeks. Here and there the remnants of the original Lexington peneplain still stand as flat table land 75 to 100 feet above the surrounding valleys. They afford ideal locations for towns due to their level surface, good drainage and beautiful outlook. Berea, Madison County, is built on such a ridge. These tablelands, however, are being rapidly eroded away by

streams and surface wash which easily cut into the shale formations of which they are composed.

The comparatively level Knob land, away from the Bluegrass, changes into hilly and mountainous topography, the shape

PLATE V. MONUMENT MARKING THE DANIEL BOONE TRAIL, BOONE'S GAP.
The Wilderness Road also passed across the Knobs at this point.

of many of these hills giving this physiographic division its name of Knobs. These knobs often rise impressively above their foothills and finally merge into the mountain and plateau areas from which they have been detached by erosion. The more isolated knobs rise above a more or less gently dissected topography; but as the mountain and plateau regions are approached the knobs cluster closer together. In the more rugged sections, such as in southeastern Madison County, the valleys become narrow and steeply V-shaped. The roads disappear into trails that follow the creeks. On either side of the path the knobs tower to mountainous proportions.

The heights of several knobs in various counties, above their adjacent valleys, are shown in the following table:

County	Elevation Above Sea Level		Height Above Adjacent Valley Ft.
	Base of Knob. Ft.	Top of Knob. Ft.	
Bullitt	480	740	260
	520	800	280
Boyle	1,000	1,050	50
	1,000	1,300	300
Estill	700	800	100
	600	1,100	500
	600	1,400	800
	600	1,500	900
Garrard	1,000	1,300	300
Jefferson	460	520	60
	500	620	120
	500	760	260
	500	820	320
Lincoln	900	1,100	200
	900	1,200	300
Madison	950	1,050	100
	1,000	1,500	500
	1,000	1,650	650
Montgomery	900	1,100	200
	900	1,400	500
Powell	700	1,300	600
	700	1,400	700
Rockcastle	1,000	1,100	100
	1,100	1,575	475

This table giving the heights above their valleys of various knobs when used with the geologic map of Kentucky shows that the knobs are higher where they are near the Pennsylvanian rock formations. Thus in Estill, Madison, Powell, Rockcastle and other counties where the knobs are nearest to the Pennsylvanian strata, they rise to the greatest heights above

their valleys, as shown in Plate VI. Where miles of Mississippian formations intervene between the Pennsylvanian and the knobs, the streams' gradients are much more gentle and the

PLATE VI. RUGGED KNOB TOPOGRAPHY.

View from the summit of Bear Mountain, Madison County, looking north. The second mountain on the right is West Pinnacle, an extension of Indian Fort Mountain. The level surface of the Lexington peneplain is seen in the distance.

knobs between become lower, as in the southern and western portions of the Knob Belt, Plate VII.

The northeastward and northward facing margin of the Knobs on the side away from the Bluegrass from Bullitt to Rockcastle County is known as Muldraugh's Hill. The westward fronting margin on the side away from the Bluegrass from Rockcastle County to the Ohio River, which borders Lewis

PLATE VII. THE SOUTHERN KNOBS.
Boyle County, looking south.

County, is the Coal Measure Escarpment, except where a belt of Mississippian strata intervene as in Lewis and Rowan counties. The valley floors from which the Knobs rise, are lowest near the Ohio River which forms the base-level for the Knob belt. The history of the formation of the Knob topography is given in this report under Historical Geology.

The Knobs that are composed of Waverly sandstone and shale are conical in form; those capped by Mississippian limestone or Pottsville conglomerate, have flat tops rimmed by perpendicular cliffs, 50 to 200 feet high. These level summits may afford good farm land. In prehistoric times they were used, in some places, by the Mound Builders as forts. Indian Fort near Berea, Madison County, is considered the largest stronghold of its kind in Kentucky.

CHAPTER II

GEOLOGY

The Knobs are made up of rock formations extending in age from the base of the Silurian into the Mississippian, and in places into the Pottsville of the Pennsylvanian System.

Geologic History. The geologic history of the Knobs Belt is shown by the character and position of the rock formations which are given in the accompanying geological column.

Beginning at the close of the Oswegan stage of the Silurian System, earth movements caused the strata to emerge from the sea, which then covered this portion of the United States, in a low anticline. (Ref. 82:54). Due to this and subsequent crustal movements, a long fold was formed which is now called the Cincinnati Arch or Anticline. The axis of this Arch extends from the State of Ohio across the Ohio River into Kentucky at Point Pleasant, about 20 miles upstream from Cincinnati. Continued southward, the axis passes near Lexington and domes upward to its highest point in Jessamine County, forming what is called the Jessamine Dome. From there it pitches southwest, passing through the eastern part of Monroe County into Tennessee. Near the Kentucky-Tennessee boundary the Arch bows up into the Rutherford Dome of Tennessee.

Between the time of the birth of the Cincinnati Arch and the next submergence in the Middle Devonian age, the Arch was widely truncated by erosion. "The evidence of this," states A. M. Miller (Ref. 82:54), "lies in the dropping out in descending order of the members of the middle and lower portions of the Silurian formations as the axis of the Arch is approached, and in the absence from any portion of Kentucky of the late Silurian and early Devonian strata."

Resting upon the Niagaran of the Silurian, except in certain places in the southern Knobs, are strata of the Middle Devonian, showing that a great unconformity here occurs between the Silurian and Devonian.

In the knobs of Marion, Boyle, and Lincoln counties, throughout a strip across the axis of the Cincinnati Anticline of about 40 miles in width (Ref. 82:249), the Middle Devonian and older strata through all of the Silurian are generally absent, and the Ohio shale of the Upper Devonian rests unconformably upon the Ordovician. Patches of Onondaga limestone may occur here and there in the area, but this unconformity should be borne in mind by those locating places to drill for oil. In Upper Devonian times the sea covered the Knobs and other regions and the Ohio black shale was laid down. Land conditions occurred at the end of the Devonian and erosion took place. The seas then came over the land and Mississippian strata were deposited unconformably upon the Devonian. Occasionally during the Mississippian Period the strata would emerge from the sea, erosion take place, and the sea again sweep over the land upon which strata would be laid down unconformably. The Bedford-Berea formations of the Mississippian thin out in Estill County and the Sunbury shale, if present, comes down unconformably upon the Ohio shale. The Ohio and Sunbury black shales are then called the Ohio shale. Other disconformities found in the Mississippian occur between the Sunbury-Cuyahoga, Waverly-St. Louis, St. Louis-Ste. Genevieve, and numerous disconformities in the Chester.

At the close of the Mississippian the sea withdrew from a large part of the eastern interior. The sediments were exposed as dry land and erosion commenced. In Kentucky the strata near the crest of the Cincinnati arch were worn away first. This beveling of the Mississippian strata caused the various formations to outcrop in belts. Deep channels were worn in the surficial Mississippian rocks. In some localities softer shales and limestones overlying the Mammoth Cave limestone were entirely eroded and the Mammoth Cave limestone itself cut into.

When the Pennsylvanian Period commenced the advancing waters moving slowly westward from a region to the east of Kentucky, encountered a much eroded land surface. Upon this uneven surface were laid down sands and gravels that became the basal sandstone and conglomerate of the Pottsville formation, Pennsylvanian System. The Pottsville varies greatly in

thickness due to irregularity of the surface of the underlying Mississippian formations, unequal rates and length of deposition, and position relative to the shore line or river bank. These Pennsylvanian rocks were deposited, at least in certain regions, entirely across Kentucky. A great unconformity thus exists between the Mississippian and Pennsylvanian Systems.

With the continuance of the Pennsylvanian Period extensive swampy areas came into existence and coal in commercial quantities began to be formed. Occasionally deeper water covered the land and shale and sandstone were formed. At the close of the Pennsylvanian, the State of Kentucky was elevated never again to be completely covered by the sea.

The enormous period of time that has elapsed since the close of the Pennsylvanian has permitted extensive erosion to take place, especially along the higher portions of the Cincinnati Arch on the Jessamine Dome. The result has been that the younger formations have been entirely worn away, exposing the underlying Ordovician strata and thereby forming the celebrated Bluegrass region of Kentucky. The younger formations are being eroded away in a circle from the center, thus ever widening the area of Ordovician surface rock. The rather uniformly even sky-line in any given region of the higher knobs and the adjacent Cumberland Plateau, has suggested to some geologists that a peneplain existed during Cretaceous times, at the elevation of the tops of the higher knobs, and "mountains" of the Cumberland Plateau whose maturely eroded surface forms the Eastern Kentucky Mountains. Other geologists believe this even sky-line to be the result of rather equal resistance to erosion, and of the structure of the underlying strata (Ref. 15; 82:195).

By Tertiary times, due to stream erosion, a base-level condition, now called the Lexington peneplain, had been attained over the Bluegrass and adjacent Knob Belt. The elevation of its surface, in general, is about 500 feet lower than the plateau level of Eastern Kentucky. Since the formation of the peneplain, at least two distinct periods of uplift and erosion have occurred, as shown by river terraces above the flood-plains of the streams. At present, as in the past, the "mountains" and

plateaus are being worn away and the Knob Belt follows the retreating highlands. On the side toward the Bluegrass the Knob Belt itself is being obliterated. The Eastern and Western Coal Fields of Kentucky owe their existence to their position down on the flanks of the Cincinnati Anticline where they have not been eroded so rapidly as have the formations at, or nearer the crest of the Arch. These two coal fields, and hence the Appalachian and Eastern Interior Coal Fields of which they respectively form parts were once connected, at least in certain portions of Kentucky.*

Due to the erosion of the Cincinnati Arch described above, the position of the outcrops of the formations in the Knobs at present are as follows: The level or rolling inner border next to the Bluegrass, is composed of Niagaran limestone and shales of the Silurian System, and Middle Devonian limestone, except for comparatively short distances in the southern Knobs, where they are absent. Next outward comes the Ohio black shale of the Upper Devonian, forming the floor upon which the majority of the knobs rest. The lower knobs themselves consist of Ohio shale, and Waverly shale, sandstone, and sometimes a heavy limestone. Overlying the Waverly in the higher knobs is the Mammoth Cave limestone, and the Chester formations, both of Mississippian age, sometimes capped by Pottsville conglomerate, sandstone and shale with occasionally one coal seam about 1 to 2½ feet thick. The basal Pottsville conglomerate is not everywhere present, sandstone taking its place.

The age and kind of rock formation that caps a knob results from the amount of erosion that has taken place. The smaller knobs rise only into the Ohio shale or lower portion of the Waverly. The mountainous knobs may still be topped with 150 feet or more of Pottsville formations carrying a seam of coal.

Stratigraphy

The formations occurring in the Knobs, starting with the Silurian and considered in ascending geologic order are here

* A Pottsville Filled Channel in the Mississippian," W. G. Burroughs: Kentucky Geological Survey, Series VI, Volume 10, pages 115-127, map, 2 sections, 1923.

given. The thickness of the strata varies considerably in different regions. In some portions of the Knob Belt certain strata may be missing as previously explained.

GEOLOGICAL FORMATIONS OF THE KENTUCKY KNOBS

With Their Thicknesses, Characteristic Fossils and Economic Products.*

Group	System	Series	Stage	Sub-Stage	Character of Deposits and Economic Products	Characteristic Fossils	Thickness in Feet
Paleozoic	Pennsylvanian	Pottsville	Lee		Mainly shales and thin sandstone. Coal from one seam 12 to 30 inches.	Land plant remains.	0 to 90+
				Rockcastle in S. E. Ky.	Sandstone, usually conglomeritic. Cliff forming.		0 to 65
	PRONOUNCED DISCONFORMITY						
	Mississippian	Chester (Kaskaskia)	Pennington represents upper part in S. E. Ky.		Mainly soft red and green shale. Fossiliferous limestone and shaly sandstone. Southeastern Knobs only. Near Berea, Madison County.	Sulcapinna missouriensis, Sigillaria, Lepidodendron, Cardiopteris.	0 to 35
				Glen Dean (Sloans Valley)	Limestone, shale partings. Macadam, Agr. lime, Eastern Knobs.	Prismonora serulata, Archimedes laxus, Pentremites godoni.	0 to 48
				Golconda	Mainly green shale, yellow limestone (near Berea).	Pterotocrinus capitalis, Pentremites obesus.	0 to 3+
				Gasper (Tribune)	Limestone (oolitic). Buildingstone (Bowling Green) Agr. lime.	Talarocrinus patei, Pentremites godoni, P. pyriformis.	0 to 60

*Based on Geology of Kentucky, by A. M. Miller. Kentucky Dept. of Geol. and Forestry, Series V, Bulletin 2, 1919, with changes made to apply to Knob Belt.

GEOLOGICAL FORMATIONS OF THE KENTUCKY KNOBS—Continued.

Group	System	Series	Stage	Sub-Stage	Character of Deposits and Economic Products	Characteristic Fossils	Thickness in Feet
Paleozoic	Mississippian	Mammoth Cave. Best developed in W. Ky. (Newman in part in E. Ky.)	Ste. Genevieve	Ohara	Limestone, macadam, Agr. lime.		20 to 55 in eastern Knobs.
				Rosinclare	Sandstone.	Platycrinus huntsvillae, Lithostrotion hermodites.	
				Fredonia	Limestone (oolitic). Building stone. Agr. lime.	Lithostrotion harmodites.	0–245 outside of Knobs.
			SLIGHT DISCONFORMITY				
			St. Louis	St. Louis	Limestone (contains chert). Building stone, macadam, R. R. ballast, Agr. lime. ...	Lithostrotion canadense and proliferum.	0–55 in eastern Knobs. 0 to 500 outside of Knobs.
		DISCONFORMITY IN EAST KENTUCKY					
		Waverly	Warsaw	Spergen (Salem), E. of Cin. Arch.	Limestone. Crinoidal. Macadam. Agr. lime.	Zaphrentis elliptica, Pentremites conoideus.	0–20
			Mainly on summit and W. side of Cin. Arch.	Harrodsburg (Ind.)	Limestone (siliceous). W. of Cin. Arch. Impure, yellow; E. of Arch in Estill, Powell, Menifee and Madison Cos.	Spirifer lateralis, Productus magnus.	0–80
				Wildie	Sandstone or Rockcastle freestone. Glauconite (green) shale.		0–6+ 0–18 inches

GEOLOGICAL FORMATIONS OF THE KENTUCKY KNOBS—Continued.

Group	System	Series	Stage	Sub-Stage		Character of Deposits and Economic Products	Characteristic Fossils	Thickness in Feet
		Waverly* (Knobstone)	Logan	Vinton, N. E. Ky. Allensville, N. E. Ky. Byer, N. E. Ky.	Holtsclaw, N. W. Ky. Rosewood, N. W. Ky.	Sandstone and shale. Building stones as far south as Rockcastle Co. on E. side of Cin. Arch. "Big Injun" oil sand at top under cover in N. E. Ky.		160-530
				Berne, N. E. Ky. Black Hand, N. E. Ky.	Kenwood, N. W. Ky.	Sandstone		
Paleozoic	Mississippian	Outcrops in a semi-circle from Vanceburg to Louisville, in S. Central Ky.	Cuyahoga	New Providence, Ind. Raccoon of Ohio		Shale, to the N. E., it contains sandstone (Lewis and Rowan County building stone). To the south and west it contains limestones. One of these is the Beaver oil sand of Wayne Co. Phosphatic concretions at the base.	Cyathaxonia cynodon. Taonurus caudagalli. Fragments of large crinoid stems.	100-200
			Kinderhook	Sunbury. South of C. & O. R. R. in its E. outcrop it rests directly on the Ohio		Black shale. Oil formerly distilled from this shale at Vanceburg.	Lingula melie and Ctenacanthus fish remains.	3-16
				Berea, E. side of Cin. Arch., N. of C. & O. R. R.		Sandstone, usually strongly ripple marked. Building stone near the Ohio R. in Lewis Co. The Berea Grit of the oil well driller in Ohio, Pa. and N. E. Ky., where struck under cover.		0-22

*See New Providence Group. Butts, Charles, Mississippian Series in Eastern Kentucky. Ky. Geol. Survey, Series VI, Volume 7.

GEOLOGICAL FORMATIONS OF THE KENTUCKY KNOBS—Continued.

Group	System	Series	Stage	Sub-Stage	Character of Deposits and Economic Products	Characteristic Fossils	Thickness in Feet
				MINOR DISCONFORMITY			
	Mississippian	Waverly	Kinderhook	Bedford. East side of Cin. Arch. N. of C. & O. R. R.	Shale .		0-95
				DISCONFORMITY			
Paleozoic	Devonian	U. Devonian	Genesee	Ohio. (New Albany and Chattanooga in part.) Outcrops in a semi-circle from Vanceburg to Louisville and in S. Cen. Ky. in patches on summit of Arch.	Black shale. Bituminous. The horizon of the gas in the Meade Co. field. The shale contains pyrites, the source, as the result of oxidation, of the sulphur and the iron in the spring water of reputed medicinal value found along its out-crop	Lingula spatulata. Dinichthys. Silicified wood (Dadoxylon, a Cordiates genus).	25-245
				DISCONFORMITY			
		M. Devonian	Hamilton	Delaware (Sellersburg). Only on W. side of Cin. Arch.	Limestone: Divided in Jefferson Co. into two members. Beechwood above and Silver Creek below. The latter the "cement rock" quarried and calcined at Louisville.	Spirifer granulosus, Tropidoleptus carinatus, Dolatocrinus tuberculatus, and many corals.	0-24
			Onondaga	Columbus. (Jeffersonville on W. side of Cin. Arch.) (Boyle)	Limestone: magnesian, cherty and frequently porous—the oil sand of the Estill, Ragland and Campton pools, probably that of the Scottsville and Glasglow; and the gas sand of the Menifee field. By replacement it furnished the oolitic carbonate iron ore of the Preston Ore Banks of Bath Co.	Spirifer acuminatus. Spirifer gregarius, Stropheodonta hemispherica and most of the corals constituting the coral reef at the Falls of the Ohio at Louisville.	0-35

GEOLOGICAL FORMATIONS OF THE KENTUCKY KNOBS—Continued.

Group	System	Series	Stage	Sub-Stage	Character of Deposits and Economic Products	Characteristic Fossils	Thickness in Feet
	PRONOUNCED DISCONFORMITY						
Paleozoic	Silurian	Niagaran	Only on W. side of Cin. Arch.	Louisville	Limestone: magnesian. Building stone.	Strombodes pentagonus. Caryocrinus indianensis, Conchidium knappi, Pentamerus oblongus.	0–100
				MINOR DISCONFORMITY			
				Waldron	Shale		0–15
				Laurel	Limestone: dolomitic. Building stone.	Whitfieldella nitida.	0-40
			Alger (E. of Cin. Arch.) Osgood* (W. of Arch).	Estill (E. of Arch.)	Shale.	Chonetes venustus.	0–100
				Waco (E. of Arch.)	Limestone: magnesian. Shale.	Favosites gothlandica.	0–10
				Lulbegrud, E. of Arch.	Shale		0—15
			Indian Fields	Oldham	Limestone: magnesian. Shale.	Strictlandina norwoodi.	0—15
			(Only on E. side of Cin. Arch.)	Plum Creek	Shale and thin-bedded limestone.		0-5
				Brassfield (Ky. and Ohio Clinton)	Limestone: magnesian. Oolitic hematite (flaxseed iron ore of Bath Co. Possibly the oil sand of Allen Co.)	Fluted crinoid stem plates. Cyathophylium calyculum, Whitfieldella subquadrata.	0–20
	DISCONFORMITY						
	Ordovician						

*See page 21 of this report for definition of Osgood by Charles Butts.

Silurian System

Niagaran Series. Geologically the oldest and lowest formations of the Knobs belong to the Silurian System. Only the Niagaran Series is present. "The lower part of the Upper Oswegan," states A. M. Miller (Ref. 82:54), "(unless ultimately the upper part of the Richmond and the whole of the Brassfield shall be placed in it) and the upper, Cayagan Divisions, are wanting." The total maximum thickness is about 320 feet.

Brief descriptions of each of the stages of the Niagaran are as follows:

The Brassfield Sub-Stage is made up of a magnesian limestone of a somewhat reddish sandy appearance. In thickness it varies from 0 to 20 feet. On the western side of the Knob Belt it is thinner than on the eastern side. In Bath County, near Olympia, on Rose Run the Brassfield limestone contains an oolitic hematite called "flaxseed" iron ore. The characteristic fossils are given in the geologic column.

The Osgood Stage as defined by Charles Butts(Ref. 11:77) includes the beds between the Brassfield limestone below and the Laurel dolomite above. Thus the Indian Fields Stage of Foerste would form at least a part of the lower portion of the Osgood. This Indian Fields Stage has been identified on the eastern side of the Cincinnati Arch. It consists of two sub-stages. The Plum Creek sub-stage is made up of bluish gray shale and thin-bedded limestone layers from 0 to five feet thick. The Oldham sub-stage includes thin bedded magnesium limestone. interbedded with shale, the total thickness varying from 0 to 15 feet. The Osgood above the Indian Fields formation consists of Lulbegrud shale, 0 to 15 feet in thickness, the Waco sub-stage made up of magnesian limestone and shale 0 to 10 feet thick, and the Estill shale from 0 to 100 feet thick. The Estill on the east side of the Arch is the top formation of the Niagaran, the Middle Devonian having been laid down unconformably upon it.

The Laurel dolomitic limestone varying in thickness from 0 to 40 feet, occurs on the west side of the Cincinnati Arch. In places it is used as a building stone. Next above comes the Waldron shale which is from 0 to 15 feet thick.

The Louisville sub-stage which forms the top of the Silurian in northwestern Kentucky, consists of a fine grained, thick bedded, magnesian limestone with a maximum thickness of about 100 feet. It is separated from the underlying Waldron shale by a disconformity.

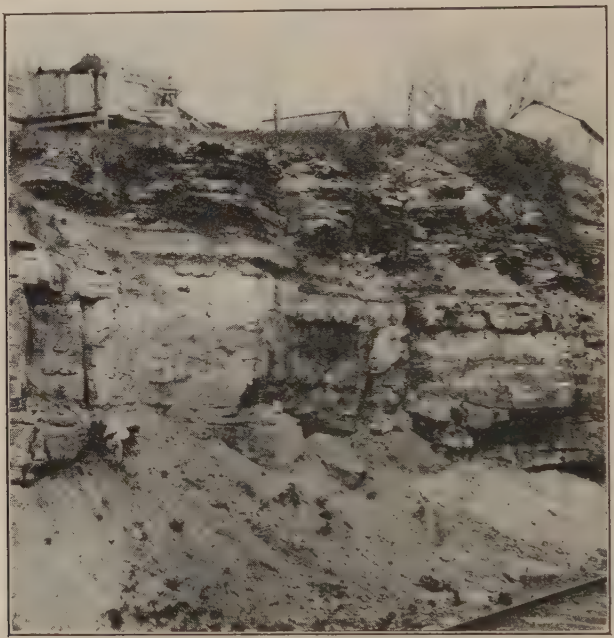

PLATE VIII. SILURIAN AND DEVONIAN FORMATIONS.
Estill shale, Onondaga limestone, and Ohio shale exposed in cut of the Louisville & Nashville Railroad in the western part of Irvine, Estill County. The lighter colored bands and nodules in the Onondaga limestone are chert which is characteristic of this formation. The Onondaga limestone a few miles northeast of this outcrop forms the oil reservoir of the Irvine Oil Pool.

The outcrop of the Silurian System in the Knobs of Kentucky extends on the eastern part of the Knob Belt from the Ohio River southward through the counties of Lewis, Mason, Fleming, Bath, Rowan, Montgomery, Clark, Powell, Estill, Madison and into a part of Garrard and Lincoln. Continuing westward in the Knobs from eastern Lincoln to western Marion, it is practically absent for a distance of about 40 miles, the Devonian throughout most of this interval resting upon the Ordovician. Northward from Marion County the Silurian out-

crops in the Knobs counties of Nelson, Bullitt, Jefferson, Oldham and stretches on through western Trimble. An outlier of Niagaran age occurs in Shelby County of the Bluegrass and is known as Jeptha Knobs.

The strips of Knob territory formed by the Silurian are from zero to twenty miles in width. The topography is comparatively level, the soils not especially good. The economic products consist of mineral water, salts as from Crab Orchard shales of Lincoln County, building stones and iron ore.

Devonian System

The Lower Devonian is missing in the Knobs of Kentucky. The Middle Devonian rests unconformably upon the Niagaran of the Silurian except in the southern Knob area where the Middle Devonian and Silurian are usually absent. The Middle Devonian consists of the Onondaga and Hamilton limestones.

The Onodaga is also known as the Columbus, Jeffersonville and Boyle formation. It is a massive, gray, cherty, magnesian limestone having a maximum thickness of from 0 to 35 feet. A typical outcrop is shown in Plate VIII. It is sometimes quite porous and when thus occurring under sufficient cover, serves as a reservoir for oil and gas as in the Irvine and a number of other oil fields. Indeed this limestone is the greatest oil horizon in Kentucky. The Onondaga has been changed by replacement into oolitic siderite which on weathering, has changed into limonite near Preston Station, Bath County. This limestone apparently is the only one of Devonian age on the east side of the Cincinnati anticline where it rests on the Estill shale of the Niagaran. But where the southern Knobs cross the Arch, the Onondaga is often absent. Patches of Onondaga are found in Taylor, Adair and Pulaski counties outside the Knob area. It extends along the western Knobs as far north as Oldham County and is the chief formation that causes the falls of the Ohio at Louisville. A portage in the earlier days of Kentucky around these rapids gave the initial start to the city of Louisville.

Overlying the Onondaga, but only on the west side of the Cincinnati Arch, occurs the Hamilton, also known as the Del-

aware and Sellersburg limestone of the Middle Devonian. In thickness it varies from 0 to 24 feet. The lower part, called by Charles Butts the Silver Creek, is a thick bedded, aluminous, magnesian limestone from which was made the natural cement known as "Louisville cement." The upper portion of the Hamilton is a crynoidal limestone, known as the Beechwood.

PLATE IX. BEREA SANDSTONE.
Note the ripple marks here about four inches wide, which are characteristic of the Berea in Kentucky and southern Ohio. Scene at Alum Rock, Vanceburg, looking westward. Photo by Chas. Butts.

The Upper Devonian, Genesee Stage, is made up of the Ohio black shale known in certain localities as the New Albany and Chattanooga. It is a black, carbonaceous, fissile shale. It rests unconformably upon the underlying formations. Prof. A. M. Miller already has written regarding this unconformity in the southern portion of the outcrop (Ref. 82:249): "The belt in Southern Kentucky along the crest of the Cincinnati Anticline, where the Silurian is commonly absent, is about forty miles wide. Along this belt the Ohio black shale nearly everywhere rests directly upon the Ordovician (Richmond or Maysville beds.) Within this belt there are many localities where this phenomenon may be observed, for instance in the upper Salt River drainage of Marion and Boyle counties, the upper Dix and Green River drainage of Lincoln and Casey counties

and in Russell, Cumberland and Monroe counties along the Cumberland River south of the mouth of Cub Creek. Generally along the plane of contact in this region there are a few inches of sand or clay, often phosphatic, intervening between the Ordovician limestone and the Devonian shale. Sometimes, however, the shale rests directly on the limestone, and, where the latter is fossiliferous, may have on its under side impressions of Ordovician fossils." The Ohio shale decreases in thickness from about 245 feet in the northern part of the Knobs to somewhat less than 25 feet in the southern part of the state.

The Ohio shale outcrops in the typical Knob counties in a belt separated from the Bluegrass by the Silurian formations, where present. The topography is made up of low knobs with flat stretches between, which act as foothills to the knobs proper. In the rougher Knob area the Ohio shale forms the bottoms of the larger valleys, and the base on which the Mississippian Knobstone formations and Pennsylvanian Pottsville rest.

The oily matter which the Ohio and Sunbury shales contain, has led some to believe that oil can be economically distilled from these formations. This subject of oil shale will be discussed later in this Report. The Ohio shale also contains iron pyrites scattered through it. Due to this mineral and other substances, mineral water often issues from along the outcrop of this formation. The soil formed from the Ohio shale is naturally not very productive but can be built up by proper methods of agriculture into excellent farming land.

Mississippian System

The Mississippian System is separated from the underlying Devonian by an unconformity.

Waverly Series. The Bedford Formation of the Kinderhook Stage, is the lowest strata of the Waverly series. It is chiefly a soft, greenish or bluish shale whose maximum thickness in Lewis County is about 95 feet, but southward thins, due to lack of deposition, until it disappears in Estill County.

The Berea sandstone rests unconformably upon the Bedford formation. It is a thick bedded, fine grained, gray sandstone containing even ripple markings which help to identify it in

northeastern Kentucky. Where the Berea has sufficient cover, it is an important source of oil and gas in certain sections of Ohio, Pennsylvania, West Virginia and northeastern Kentucky. Excellent grindstones and building stones are made from it in Ohio. At Vanceburg, Kentucky, where it is 22 feet thick, the Berea has been quarried for building stone. Southward it disappears along with the Bedford in Estill County.

The Sunbury, the top formation of the Kinderhook Stage, is a black, fissile, carbonaceous shale which at Vanceburg has a thickness of about 16 feet. In the northern part of the Knobs it is separated from the Ohio shale by the Bedford-Berea formations. At Irvine, Estill County, the Sunbury is about three feet thick and is separated from the Ohio shale by only 18 inches of gray clay, or shale, which represents the Bedford. Here the Ohio shale is about 95 feet thick. Southward from Irvine the Sunbury has not been definitely recognized as a separate unit.

In northern Lewis County the total thickness of the Sunbury and Ohio shales is about 261 feet. With the disappearance of the Bedford-Berea formations the Sunbury and Ohio shales come together. At Junction City, Boyle County, their combined thickness is 40 feet and this thinning continues southward. The black shale through the counties south and west of the Bluegrass to Louisville, according to Butts, is mainly a thin extention of the Ohio shale, although it may include a very thin representative of the Sunbury at the top.

The Cuyahoga and Logan Stages of the Waverly are the next two formations in ascending geologic order which go to make up the Knobs. Each is divided into several sub-stages which are shown in the geologic column. The Cuyahoga and Logan formations are classed by Butts as the New Providence group. The strata included by Miller in the formations are somewhat different from those given by Butts. The Cuyahoga which forms the lower portion consists predominately of soft, grayish green shale with sometimes a concretionary bed of lime and iron carbonate about eight inches thick. Thin bedded, calcareous layers occur. Spherical concretions composed of iron and lime carbonate are prevalent in this soft shale of the Cuyahoga. Phosphatic nodules are found in certain localities. A

sandstone, known as the Buena Vista, which has been quarried for building stone, makes its southern appearance in the Cuyahoga in the vicinity of Stanton, Powell County, where it is separated from the Sunbury by five feet of shale (Ref. 12:42). Northward this formation becomes thicker. At the base of the Buena Vista is an even-bedded, bluish-gray sandstone, 2½ to 3½ feet thick, known as the "City Ledge." It is of uniform grain, medium hardness and is quarried and dressed easily. Thus the Lewis and Rowan County building stone is a part of the Cuyahoga. The Logan division consists predominately of thin, shelly, gray sandstone with gray shale. A reddish clay shale, eight feet thick, occurs in certain localities.

The New Providence rocks of Butts extend from Jefferson County, Kentucky, southward and then northward around the Knobs through Lewis county. They also occur elsewhere in Kentucky. In Jefferson County the New Providence formations are 150 to 160 feet thick; near Lebanon, Marion County, 258 feet; King's Mountain, Lincoln County, about 300 feet; near Berea, Madison County, 400 feet; Lewis County, 600 feet (Ref. 12:47, 49).

The economic products are the Buena Vista building stone already mentioned and the soft New Providence shale of the Cuyahoga which makes excellent bricks, and is used for that purpose in various places. Outside of the Knobs in Wayne County the Beaver Creek oil "sand" and in eastern Kentucky the Big Injun and Wier oil sands also belong to the New Providence group.

The Warsaw, where it occurs in the Knobs, forms the top portion of the Waverly. It is composed of limestone, shale and sandstone which change in proportion and character, sometimes within short distances. In Rockcastle County the Wildie sandstone, known as the "Rockcastle freestone," belongs to the Warsaw. This excellent building stone is thick bedded, fine-grained, bluish-gray and of medium hardness. (Ref. 12:103). It extends from about three miles northeast of Mount Vernon to a point between Owsley Branch and Irvine where it ceases. Its entire known extent in a northeast-southwest direction is about 16 to 20 miles. It is of commercial thickness for only a com-

paratively short distance. A glauconite green shale up to 18 inches thick occurs below the Wildie sandstone. The top of the Warsaw near Berea, Madison County, consists of a thick bedded, yellow, impure limestone upon which the St. Louis limestone rests unconformably. A notable feature of the Warsaw at various places is the round quartz geodes which it contains. The Warsaw extends along the Muldraugh Hill through Hardin and Larue to Taylor, Casey and Lincoln counties and southward. In the Knobs it then extends northward until it thins out between southeastern Madison County and Irvine, Estill County. The Warsaw varies in thickness from about 240 feet in Hardin County to zero some distance south of Irvine. On Owsley Branch in western Jackson County, it is 18 feet thick.

An interesting outlier of Waverly occurs in Burdett's Knob near Bryantsville, Garrard County. A small remnant of Waverly occurs on the top of the Knob. This indicates that the Waverly once extended over the Jessamine Dome, which is the highest part of the Cincinnati Arch.

The soils derived from the Warsaw limestone produce moderately good farming land, but due to deficiency in phosphates, they are greatly inferior to the phosphatic limestone soils of the Bluegrass.

The Mammoth Cave Series. The bottom portion of the Mammoth Cave series consists of the St. Louis formation which lies unconformably upon the Waverly. The St. Louis is chiefly a moderately thick bedded, fine grained, dark gray to black limestone; but blue and gray layers occur. The basal beds of the St. Louis, 13 to 18 feet in total thickness, are argillaceous, thick bedded limestone. They weather to clay. A distinguishing mark of the St. Louis is the quantity of irregular surfaced, flattish pieces of chert it contains. Abundant chert debris is seen along the weathered outcrop. The St. Louis is non-oolitic. Thus it differs strikingly from the overlying oolitic Ste. Genevieve. The St. Louis starts in Meade County at the Ohio River and stretches through Hardin, Larue, eastern Hart, northern Barren, eastern Warren and Simpson counties. Its eastern outcrop is a rather narrow belt which extends through Clinton, Wayne, Pulaski (east of Fishing Creek), and Rockcastle counties.

Northeast of Rockcastle County it occurs near the tops of the higher knobs and thins out entirely not far northeast of Frenchburg, Menifee County. The average thickness in western Kentucky outside of the Knob Belt, is about 300 feet with a maximum of 500 feet; in the eastern Knobs, Madison County, about 55 feet; at Irvine, Estill County, 25 feet (Ref. 12:125-127).

The Ste Genevieve* lies unconformably upon the St. Louis. A fine conglomerate layer a few inches thick is found in places in the basal portion of the Ste. Genevieve. Tiny quartz pebbles also occur scattered through the limestone in portions of the eastern Knobs. The Ste. Genevieve is a gray, generally oolitic, thick bedded limestone, interbedded with non-oolitic limestone layers. The thicker layers of the Ste. Genevieve weather a distinctive white color. Thin layers occur in certain regions as near Berea. The Ste. Genevieve outcrops in a belt from the Ohio River in western Meade County southward to Tennessee; east of the Bluegrass in a narrow strip from Tennessee to the Ohio River. The towns of Monticello, Somerset and Mt. Vernon are along this outcrop. This limestone occurs near the tops of the higher knobs. Conspicuous cliffs are formed from it. The Ste. Genevieve proper as classified by Butts is 45 to 55 feet thick east of Berea, Madison County; at Irvine 20 to 25 feet; and continues northward with about the same uniform thickness.

The Mammoth Cave limestone is suitable for ballast, concrete, road metal, and agricultural lime. The oolitic beds of the Ste. Genevieve where of great purity may be used for the manufacture of lime and cement.

The Chester Series. The Chester series consists of sandstones, shales and limestones. Parts of this series occur in the higher knobs. Sometimes, however, where due it is almost if not entirely lacking, having been eroded before deposition of the Pottsville, Pennsylvanian System.

The light gray, generally thick bedded, oolitic limestone known as Gasper, outcrops along both the east and west sides of the Bluegrass, but the two belts are nowhere connected. The western belt extends from the Ohio River in western Meade

*Charles Butts in the Mississippian Series of Eastern Ky. Ky. Geol. Surv., Ser. VI, Vol. 7, p. 137, states that E. O. Ulrich "places the entire Ste. Genevieve in the Chester Group. This arrangement is opposed by Stuart Weller."

County to central Warren, and is therefore west of the typical Knob area. (Ref. 12:159). In the eastern strip it forms the upper portions of some of the higher knobs. At Irvine it is 50 feet thick; on Morris Mountain, Powell County, 40 feet; at Olive Hill, 45 feet. The Gasper at present is used for ballast and road

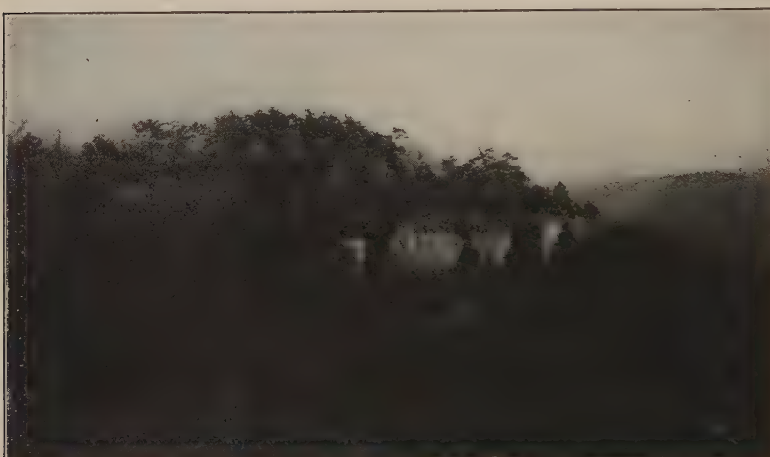

PLATE IX-A. THE CLIFFS OF BASIN MOUNTAIN.

View, looking eastward, shows the southeast end of the newly discovered prehistoric fort, located in southeastern Madison County. The light gray Mississippian limestone at this part of the mountain is broken into two cliffs with a narrow terrace between. The Pottsville conglomerate overlies the limestone and forms a cliff which is continuous around the summit of the entire knob except where the ravine cuts back nearly to the "basin." Pilot Knob of Madison County is in the distance at the right.

metal. It can be quarried and crushed for agricultural lime, and where very pure, it may be suitable for lime and cement manufacture. Some of the clay shales of the Chester in the Knobs might be utilized for brick. Outside of the Knobs the Cypress sandstone is in places quarried for its rock asphalt. The Golconda, Glen Dean and Pennington formations, as described in the geologic column, are found near the tops of a few of the higher knobs in the southeastern part of the Knob Belt.

Pennsylvanian System

Th Pottsville Series lies unconformably upon the Mississippian. In places it consists of the basal Rockcastle conglomerate up to 65 feet thick, which in the Knobs, however, is rather

patchy. Shales and sandstones make up the remainder of this series as found in the Knobs. A coal seam, 12 to 30 inches thick, occurs in a few of the eastern Knobs in the lower portion of the Pottsville above the Rockcastle conglomerate. It is of slight economic importance, however. The great majority of the knobs are too low to catch this coal horizon.

Structural Geology

The largest structure in the rock formation of the Knobs Region is the Cincinnati Anticline.

Smaller structures that are important in determining the location of oil and gas fields in the Knobs are as follows:

(1). *The Irvine-Paint Creek-Warfield Fault and Anticline.* This structure extends from near Irvine, Estill County, east to the Big Sandy River in Johnson County. (Ref. 54:40). South of and parallel to the main fault one-half to two miles distant, usually occurs a secondary fault. The block of rock formations between these two faults dropped downward, the maximum throw of the fault being from 150 to 200 feet. South of the faults the rocks are folded into an anticline. Oil and gas have been discovered along this anticline and smaller structures associated with it. These pools are the Irvine, Station Camp, Ross Creek, Big Sinking, Ashley, Campton, Stillwater, Cannel City, Paint Creek, Laurel Creek and Inez.

(2). *The Joe Lick-Combs Mountain Fault.* This structure usually consists of two parallel faults with a downfaulted block between. It has been traced from Garrard County through southeastern Madison County to Joe Lick Knob thence past Combs Mountain into Estill County where it joins the Irvine fault. On its south side the rock formations have been folded into an anticline in a similar manner to the Irvine-Paint Creek fault and fold.

Smaller faults and folds occur in Estill and adjacent counties and probably are related to the Irvine fault. Future oil development in these counties should be undertaken only after detailed study in the field of the structure encountered in these areas.

(3). *The Kentucky River Fault.* This large structure and its associated faults are normal faults which extend from near Burdett's Knob, Garrard County, probably to Ragland, Bath County. The maximum throw is 350 feet, (Ref. 82:234), and

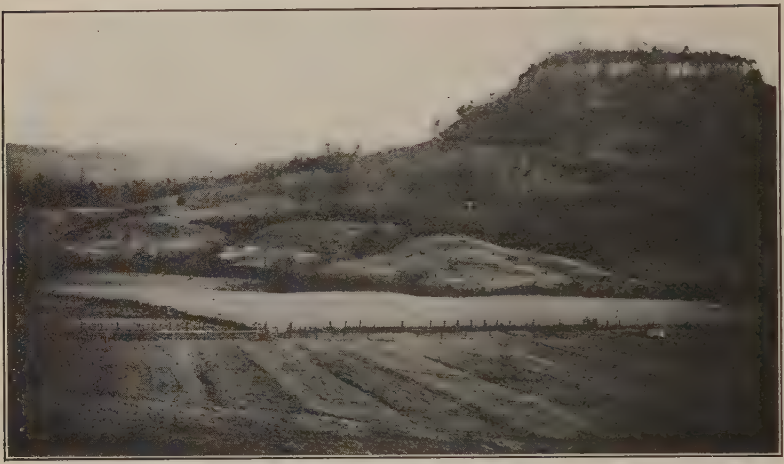

PLATE X. PILOT KNOB, MADISON COUNTY.

Bottom land in Ohio shale, Waverly formations forming knob slopes to the base of Mammoth Cave limestone which rises in perpendicular cliffs topped by Gasper limestone.

occurs midway of the fault zone. For a part of the distance a secondary fault accompanies the main fault. Near the northeast end of the Kentucky River Fault proper, it is continued by another fault called the Jackson Ferry-Camargo Fault which has been traced from Jackson Ferry, Clark County, to Camargo, Montgomery County. (Ref. 82:235). The total length of the Kentucky River Fault and the Jackson Ferry-Camargo Fault is about 50 miles. The Ragland Oil Pool is believed to be a monoclinal fold which continues from the Camargo end of the fault.

Numerous smaller folds occur in the Knobs, and in some of them, as near Berea and in Rockcastle County just south of Boone's Gap, oil and gas have accumulated. The drill alone can prove whether or not these structures contain petroleum in economic quantities.

Special physiographic features occurring in the Knobs are caves in the Mammoth Cave limestone and "rock houses," formed especially in the sandstone and conglomerate near the tops of the knobs. In these lower portions the rock has been weathered away more rapidly than in the higher layers, thereby forming a recess in the face of the cliff. It was in such "rock houses" that the author and party discovered the prehistoric graves described later in this report. Natural bridges occur in Knob counties, as at Natural Bridge Station, Powell County. The knobs form "outliers" with younger strata on their tops such as Mississippian limestone, surrounded by valleys of older rocks as, for instance, the Devonian Ohio shale. Pilot Knob, Madison County, is an example, Plate X. The Knobs also contain all of the usual stream and topographic features.

CHAPTER III

CLIMATE

The Knobs of Kentucky have the humid, temperate, continental type of climate. Neither difference in elevation nor distance of latitude have affected the climate to any marked extent in the various portions of the Knobs. There is, however, some variation in climatic conditions between the Knobs and the adjacent physiographic divisions which will be described. The small variations in the average precipitation at the several Knob Weather Stations* are probably due chiefly to the varying exposure of the rain gages and the varying length of time of the records.

Winds and Storms

The western Knobs lie within, and the Knobs as a whole within or near, the path of the moisture bearing storms which move from the western Gulf region northeastward over the Mississippi-Ohio valleys to the Great Lake region and the North Atlantic coast. These large storm areas, which vary greatly in frequency, character and force, are the chief agents in determining the greater portion of the precipitation over most of this section.

The prevailing annual winds are from the southwest, except during certain months of the year in sections of the Knobs as follows: Berea, in the eastern Knobs, has its exceptional wind in October when it blows from the northwest. The wind at Shelby City, in the southern curve of the Knobs, is from the west in February, and from the south in October. Bardstown, in the western Knobs, receives winds from the southeast in April and September, and from the south in June. Anchorage in the northwestern Knobs has winds from the northwest in December and February.

Thus the northern part of the Knobs receives winds from the northwest for a longer period than any other part of the

*Climatological data based on U. S. Weather Bureau Reports.

Knobs, but even here the wind for the year as a whole is from the southwest.

The annual average velocity of the wind at Louisville, on the border of the northwestern Knobs, is 7.9 miles per hour, for a record extending over 44 years. During the winter months the average velocity was from 8.7 miles per hour in December to 9.7 miles per hour in February. In the spring, the March winds blew with an average velocity of 9.8 miles per hour which was the highest monthly average for the year. April had an average velocity of 9 miles, and May 7.5. The summer months averaged from 7.1 in June to 6 miles per hour in August. During the fall months, the average velocity increased from 6.4 in September to 8.4 in November. The average wind velocity therefore varied from 9.8 miles per hour in March to 6 miles per hour in August. Thus the winter and early spring have average wind velocities greater than the other seasons of the year, the most gentle winds, as a whole, being in the summer.

Wind storms so severe that they cause loss of life, and destruction of property are unusual. They do, however, occur. During the preparation of this report, two violent wind storms swept over the Knobs in the winter of 1923. The night of January 7, a hurricane struck Madison County. In Berea, two houses were blown from their foundations and one box house demolished, killing a baby. Barns were destroyed or lost their roofs; and trees also suffered.

The night of March 11, 1923, a second hurricane occurred which moved eastward from the Rocky Mountains. Four people were killed in Madison County near the Fayette County line when their house was blown to pieces. Barns were unroofed, windows blown in, and other damage done.

Temperature

The Knobs as a whole have a mean annual temperature of 55.7 degrees F. The annual minimum and maximum means are 44. and 67.5 degrees respectively. Table No. 3 given in the Appendix of this Report shows the monthly and annual means.

The three summer months have an average temperature of 74.6 degrees, varying between an average of 72.4 degrees in

June and 76.3 degrees in July, with 75.1 degrees in August. It usually is drier during August than in July. The mean minimum and maximum temperatures for the summer months are 62.4 degrees and 86.7 degrees. The highest temperature for the Knobs was recorded in July at Bardstown, being 108 degrees. Anchorage in July comes second with 107 degrees. Other portions of the Knobs have registered 104 degrees and 106 degrees. These extremes, at the most, last for only two or three days in succession. Ninety degrees has been reached in all of the months from March to October inclusive, while 73 degrees has been touched during the colder months.

The winter months in the Knobs have a mean average of 35.2 degrees. The mean temperature for December was 35.5 degrees, January 35.9 degrees, February 34.4 degrees. The

PLATE XI. AVERAGE DATE OF LAST KILLING FROST IN SPRING.
(After Walz, F. J. Circular 19, Ky. Agr. Exp. Station.)

minimum and maximum means for winter are 25.4 degrees and 44.7 degrees. The lowest temperatures on record since 1897 occurred in February, 1899, when 30 degrees below zero was reached. Various Knob stations show temperatures of 28 degrees and 25 degrees below zero. Unusual drops in the thermometer during the warm months of the year gave farmers in the eastern Knobs 38 degrees in June and 42 degrees in July. During the winter months the mercury has moved in the opposite direction, registering 78 to 83 degrees for both sides of

the Knob Belt, due to southerly winds bringing the warmth of lower latitudes to Kentucky.

The Spring mean temperature is 55.2 degrees, the monthly average increasing from 45.7 degrees in March to 65.4 degrees in May. The Spring mean minimum and maximum are 43.3 and 67.4 degrees.

The Autumn has a general average temperature of 57.7 degrees, the monthly average decreasing from 69.6 degrees in September to 46.0 degrees in November. The Autumn mean minimum and maximum are 44.8 and 70.7 degrees.

The seasonal and annual temperature averages remain quite constant due to the situation of the Knobs with relation

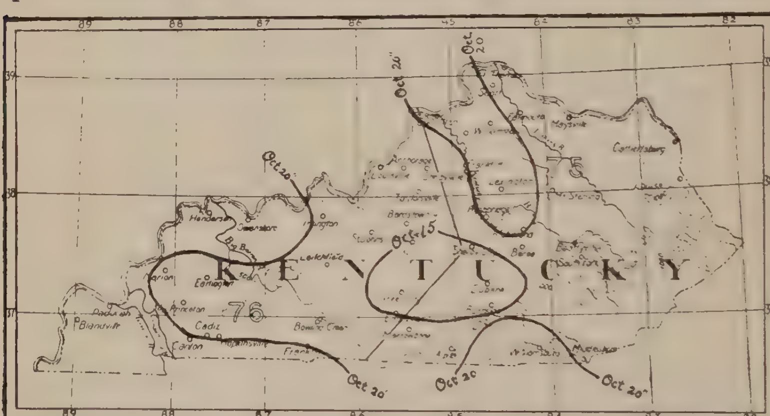

PLATE XII. AVERAGE DATE OF FIRST KILLING FROST IN THE FALL
(After Walz, F. J. Circular 19, Ky. Agr. Exp. Station.)

to the wind movements, as already described. Any extreme fluctuations that occur last for only a few days at the most.

Killing frosts are enemies which the farmer must guard against. The average dates of the last killing frost in the Spring and the first in the Fall are dates about which the actual dates fluctuate. Thus the average date of the last frost in Spring is the date when the chances are even that there will or will not be a killing frost later. The same principle holds true for the Fall. The accompanying frost maps for Kentucky, Plates XI and XII and Tables 4 and 5, in the Appendix, show that the average date of the last killing frost in the Spring is April 18 to 21; and the earliest in the Fall, October 14 to 17.

The important point for the farmer to know is the percentage of risk from frost that his crops run at various dates in different localities. Tables 4 and 5 in the Appendix of this Report show the probability of killing frosts for the Knobs and

PLATE XIII. AVERAGE NUMBER OF DAYS IN THE GROWING SEASON. CONSIDERED AS CONSECUTIVE DAYS FREE FROM KILLING FROST.

(After Walz, F. J. Circular 19, Ky. Agr. Exp. Station.)

adjacent territory. By using these tables it is seen that at Shelby City, Boyle County, for example, the probable latest dates of killing frosts in the Spring and the percentage of risk are as follows: April 21, the risk of frost is 50 per cent; April 26, 33 1/3 per cent risk, which is one year in three; May 6, 5 per cent risk, or one year in 20. The probabilities of killing frosts during the Fall are obtained from the Tables in the same manner.

The latest dates recorded by whether stations in the Knobs for a killing frost in the Spring range from May 3, 1911, to May 14, 1895. The earliest dates of first killing frosts in the Fall vary from September 14, 1902, to September 30, 1899.

The relation of the crop to the land surface sometimes has a very important bearing on whether or not a crop will be injured by a frost. In hilly land, crops in the valleys and on the lower slopes may suffer, while the higher areas may remain unharmed. Severe frosts, however, may affect all parts of the land surface and crops be damaged even on the higher

lands. Killing frosts in Spring cause damage chiefly to fruits, strawberries and early garden truck. In the Fall, the frosts may damage the corn and tobacco, the occurrence of a killing frost practically ending the season for these crops.

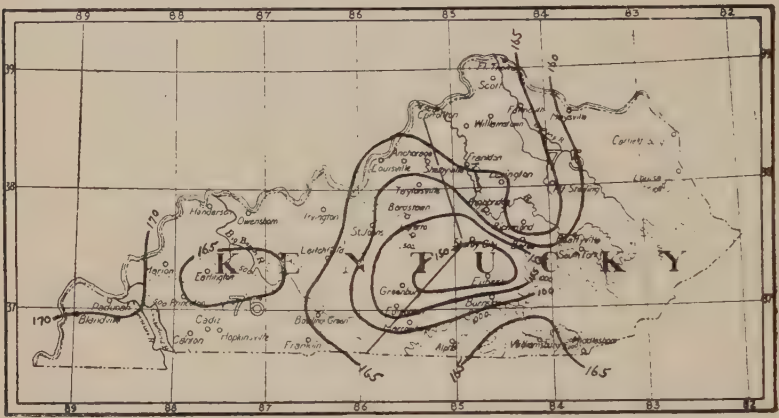

PLATE XIV. NUMER OF DAYS IN THE GROWING SEASON PRACTICALLY SURE FOUR YEARS OUT OF FIVE.
(After Walz, F. J. Ky. Agr. Exp. Station.)

The length of the growing season, or the period of safety for the plant growth, is very important. The length of the growing season is taken generally as the number of days in each season between the date of the last killing frost in the Spring and that of the first killing frost in the Fall. The accompanying maps, Plates XIII and XIV, and Table 6, show the average number of days in the growing season, considered as consecutive days free from killing frost, and the number of days in the growing season practically sure 4 years out of 5. Thus it is seen that the usually sure length of the growing season for the Knobs varies from 151 to 162 days. The range of probability is from 165 to 191 days. The shortest growing season on record for Knob stations was 152 days in 1902 at Shelby City. Other sections of the Knobs were only 2 or 3 days longer in the same year. The longest growing season on record was 206 days in 1913 at Bardstown. Other parts of the Knobs came within 5 days or less of this maximum.

The growing season is long enough to allow the maturing of corn, which is the chief field crop of the Knobs. Killing

frosts make commercial fruit growing of peaches a semi-speculative occupation in at least many sections of the Knobs. One owner of large peach orchards stated that if he secured one good crop in three years, the return from his peaches the one fruitful year made his entire investment very satisfactory. Sometimes excellent peach crops are obtained oftener than stated above.

Taken as a whole, the climate is suitable for the production of many and diversified kinds of cereals, vegetables and fruits.

Humidity and Precipitation

The mean relative humidity is somewhat higher during the Winter months than in the Spring and Summer, being in January at 7 a. m. 78 per cent, and at 7 p. m. 69 per cent which was the highest for that hour, compared with 70 per cent and 56 per cent respectively in April which was the lowest. In July the mean relative humidity at the hours mentioned was 74 per cent and 57 per cent. The variations are slight.

The Knobs are between the heavier precipitation of certain areas to the south of Kentucky, and the drier territory of the Bluegrass. During the year the average total number of days with 0.01 inch, or more, of precipitation for the Knobs counties varies from 99 days at Bardstown to 114 days at Berea. The other parts of the Knobs have an average total number of days of precipitation between the figures given above. Louisville, which spreads over into the Knob Belt, has an average total of 126 days of precipitation, this being the greatest number of days for the regions in or very near the Knobs.

March and April lead the other months in the average number of days with 0.01 inch, or more, of precipitation, having 10.8 and 10.4 days respectively. December, January and May follow, each having 10 days of precipitation.

Reckoned by seasons, Spring leads with a total average of 31.2 days of precipitation, followed in order by Winter with 28.2 days, Summer 27.4 days, Fall 19.8 days. October is the driest month with 6 days of rainfall and the quantity that does fall is slight.

The annual mean precipitation in the Knobs is 45.55 inches. The maximum annual precipitation occurred at Berea, Madison County, with 60.43 inches in 1915. The least annual precipitation occurred at Anchorage, Jefferson County, when 29.28 inches fell in 1904, and 29.79 inches in 1901. Shelby City, Boyle County, comes second in dryness with an annual precipitation of 29.8 inches in 1894. The monthly precipitation is given in Table 7. The average seasonal precipitation for the Knobs is as follows: Summer 12.97 inches; Fall 8.49 inches; Winter 11.89 inches; Spring 12.14 inches. The greatest amount of precipitation occurs in July when an average of 4.66 inches falls; March is second with 4.59 inches. The smallest average precipitation is during October when only 2.67 inches fall. September has 2.86 inches of rainfall on the average.

The annual snowfall for the Eastern Knobs total 20.5 inches; Southern Knobs 15.4 inches; Western Knobs 17.8 inches. The greatest snowfall occurs during the Winter months, December having 3.96 inches, January 4.64 inches, February 5.18 inches. The snow does not usually remain on all parts of an area for more than a few days. But it remains long enough to produce a demand for sleds for the boys and girls, and thereby is of economic importance to dealers in these articles. The snow stays longest in the shadows of the cliffs on the north sides of the Knobs, Plate XV. In an east-west valley, snow remains longest on the southern, shaded slopes. The north side will be bare of snow when the south bank of a deep ravine is still covered with a blanket of white.

Sleet or ice storms occur, and branches of trees and wires, overweighted with the burden of ice adhering to them, are broken, causing economic loss. Hail falls occasionally, and may damage crops, but the chances of such an event are not great. Glass in hot houses may be broken by hail the same as in any part of the United States.

The percentage of possible, actual sunshine in terms of hours of daylight for the entire year, is approximately 58 per cent. The Summer months have an average of 68 per cent, Fall 63 per cent, Winter 43 per cent, Spring 56 per cent. The maximum amounts of sunlight come in the late growing

and fruiting season when, in conjunction with high temperature and ordinarily sufficient rainfall, the various crops are greatly benefited.

The precipitation is well distributed throughout the year except during the dry Fall. The heavy Winter and early Spring

PLATE XV. SNOW IN THE KNOBS.

Looking east, Indian Fort is seen extending from the notch in the level topped knob on the left to the gap on the right. This knob sends off spurs to the east and west which are within the fort, but are not visible in this photograph. Scene in Madison County.

rains tie up transportation by automobile over the poor dirt roads, except during the drier spells when light cars get through. When the roads are quagmires, it is a difficult task for teams to haul wagons through the deep mud and across swollen streams where no bridges have ever been built; and some of the paths in the rougher sections are almost impassible for a loaded team at certain times.

The ground usually is frozen only to a slight depth and for comparatively short periods. Being thus unprotected for a longer period than the frozen soil of more northern regions, the Knob soil is far more liable to wash wherever the slopes are bare of vegetation. This results in a greater amount of soil erosion than would occur in the north under similar topographic and soil conditions. Also, the ground being saturated with water near the surface on many of the slopes, causes a greater per cent of the rain to run off as surface water. This together with the steep knob slopes and the heavy precipitation at certain times of the year, results in sudden fluctuations in the volumes of the Knob streams. The larger streams respond somewhat more slowly to the rainfall, but their volume is also affected.

The sandy, sloping soils dry off very quickly, but the shale and clay soils remain damp and sticky for a longer time. The effect upon the crops planted upon each of these types of soils is apparent.

PLATE XVI. THE SOUTHEASTERN KNOBS.

Pigg Hollow, Madison County, three miles southeast of Berea, looking south. About one mile up this "hollow,' a concrete dam has been built across the valley forming a reservoir.

During the growing season there is usually sufficient rainfall for the production and maturing of the staple crops. Occasionally there is too much rain, but on the other hand drouthy conditions sometimes prevail. In a season of drought, however, timely rains often occur, giving enough moisture to prevent serious disaster to the crops. About three drouthy years in each decade can be reckoned on.

The Autumn months are so dry that Berea, Madison County, found that its water supply from ten springs in the Knobs was insufficient and to meet this deficiency a concrete dam has been constructed by Berea College across a valley between two high Knobs, Plate XVI, forming a large reservoir.

CHAPTER IV

NATURAL RESOURCES

The natural resources of the Knobs include soils, mineral deposits, mineral waters, water power, native vegetation and wild animal life.

Soils

The soils of the Knob Belt taken as a whole are naturally rather poor and thin. They can, however, be built up to produce good crops. Over the greater portion of the area the soils are residual, formed chiefly from the underlying rock formations. On the steeper slopes and at their base, the residual soil may be mixed with material brought down by surface water and gravity from the formations higher up the sides of the knobs. The flood plains of the creeks and rivers contain a transported soil deposited by the stream waters. This alluvium occurs in comparatively narrow strips and is of limited extent.

The Knob soils may be considered under: (1) soils of the Lowlands; (2) soils of the Highlands.

(1). The rock formations from which the residual soils of the Lowlands are formed are as follows: The basal strata upon which the knobs proper usually rest are of Silurian and Devonian age. They form a flat or gently dissected topography in sharp contrast to the higher knobs and mountains of the Knob Belt which are composed of Mississippian strata topped in some places by Pennsylvanian formations. The soils of the Knobs bordering the Bluegrass are derived from the underlying Silurian-Devonian limestones where present. The Niagaran and Onondaga magnesian limestones do not produce particularly good soils; but in certain localities these soils are better than usual, or have been built up through scientific farming. Thus soil above the Onondaga limestone at Indian Fields, eastern Clark County, is said to be of superior fertility. (Ref. 82:78). The Niagaran shales and clays derived therefrom are often highly calcareous. Experiments conducted in the vicinity

of Berea, Madison County, by Robert F. Spence, Farm Agent, in the use of this marly shale as a substitute for crushed limestone on the fields, gave considerably increased yields.

Next outward away from the Bluegrass occurs the Ohio shale soil belt. It forms the valley floors and lies at the base of the higher knobs. Low knobs have been worn into this shale. Mixed with the soil derived from the disintegration of the carbonaceous black shale, are materials washed down from other formations situated at higher elevations. The soil above the black shale is a silt loam or silty clay, ten to sixteen inches deep, although it varies outside of these limits, having a light yellow, reddish brown, or gray color. The subsoil is a heavy silty clay or clay of a yellowish color, sometimes mottled with gray. The black shale bed rock occurs near the surface and outcrops in some places forming a slaty soil which is mixed with yellowish or brownish clay. These areas often are badly eroded by surface wash. In flat, poorly drained areas the soil is a gray silty clay with a gray, heavy clay subsoil. (Ref. 5 and 44).

Much of the Ohio shale soil areas requires artificial drainage if crops are to do their best. Neither does this soil retain moisture very well during the dry seasons. Frequent cultivation to maintain a dust mulch to conserve the soil water is necessary if good crops are to be grown, otherwise crops upon this soil are liable to suffer during a drought.

The native forest growth upon the Ohio shale soils consists of several kinds of oak, hickory, chestnut and Virginia pine. Moderately good crops are produced when the soil is first cleared, but after a few years the yield decreases greatly unless plant food is added and the texture of the soil kept in good condition. Corn is the chief crop. The yield varies from 10 to 25 bushels per acre in the Knob Belt proper.

The average yield is about 15 bushels of corn per acre in the Knobs, although this varies in different sections. Much larger production of corn can be secured by scientific farming.

Along the streams occurs a transported soil deposited during high water. It is made up of a dark brown silt or clay loam, with a brownish clay subsoil. This soil along the Kentucky River, due to its greater sorting power as compared to

the creeks, is more variable in texture, being sometimes sandy along the river bank.

The sycamore is found on these floodplains. The soil often is productive, receiving new deposits of silt in time of flood.

PLATE XVII. MUCK LAND, BEREA COLLEGE FARM.

The level land was once a swamp. The knobs of Madison County stretch away on the right into Garrard County. View from Berea looking southward.

The chief crop is corn. In the Spring this bottom land sometimes cannot be worked as soon as the uplands thereby making the crops somewhat later than those produced on the higher soils. Some portions of the creek bottoms are too stony to be of value agriculturally.

Second terraces occur along certain streams above the bottom land. The surface will be flat or gently sloping toward the main stream which once meandered over what is now a terrace before it cut vertically downward to form the present floodplain and river channel. Crops are grown along the terraces.

Muck land consisting of black, organic and earthy material occurs in limited patches in the Knob Lowlands. The subsoil is a heavy brownish clay. (Ref. 44). The groundwater level usually is only 3 to 4 feet beneath the surface even during the dry seasons.

These muck areas are the remains of swamps. The clay subsoil represents sediments deposited in the water before the dead vegetation became so thick as to make the muck which overlies the subsoil. Due to erosion the swamp was drained

leaving the muck lands. The first attempts to grow crops upon some of these muck areas are said to have failed due to the acidity of the soil caused by organic acids from the dead vegetable matter, and from lack of drainage. The Berea College farm has successfully reclaimed land of this type, Plate XVII, by lime, tile drainage, the application of fertilizer, correct rotation of crops, and similar scientific procedure.

(2). The soils of the Knobs Highlands are of various types. Those formed upon the steep slopes of the knobs, composed of weathered Waverly shale, Plate I, are usually a light gray to yellowish or brownish silt or clay loam. The subsoil is a gray, yellowish or reddish clay. On the steeper slopes the shale may outcrop or be so near to the surface that its fragments mix with the thin soil. Near the base of the Knobs where the slopes are more gentle, the bedrock may be 3 feet or more beneath the surface and the shale fragments are not so noticeable as on the steeper slopes.

The soft Waverly shale and thin overlying soil wash badly unless held in place by sufficient vegetation.

Much of the valuable timber, such as white oak, hickory, chestnut and pine, has been removed, the slopes being clothed at present over wide areas chiefly with small trees and underbrush. These Waverly soils make poor farming land unless built up by man. They drain readily, due to the steep slope, but even here the soil in places will remain damp and sticky for a considerable time after a heavy rain. Where this soil occurs along the narrow margins of creeks, it is better for agricultural purposes as far as its fertility is concerned than the Waverly soils on the steeper slopes.

Higher up on the knob slopes occur limited patches of rather sandy soil derived from the Waverly sandstone and from material washed down the slope from the Mammoth Cave limestone and Pennsylvanian conglomerate and sandstones when present. The limestone fragments carried down the knob sides by water and gravity aid in enriching the soils of the Waverly shales already described.

The native trees upon these sandy and stony areas are hickory, black walnut and poplar. Corn as usual is raised, but the soil is exhausted quickly unless plant food is added.

Above the Waverly soils comes the Mammoth Cave limestone. The limestone is covered with a residual soil which is a brown silt loam. In Rockcastle County, for example, this loam is underlain at around 15 inches by a more compact, lighter colored subsoil which changes with depth to a heavy silty clay and to a brownish red friable clay. On the steeper slopes the soil is somewhat similar. It is 8 to 12 inches deep underlain with a yellowish brown to dull red clay. The limestone sometimes outcrops. (Ref. 5). Pieces of chert are scattered through the soil above the St. Louis limestone.

The native trees are oak, chestnut, hickory, poplar, sugar maple, cedar, walnut. A large per cent of the best trees have been cut. Corn and other cereals are raised. Apples and plums are said to do well on this soil where the slopes give a good air drainage and protection from frosts that might cause damage to fruit in the valley bottoms below. Peaches are in danger of late Spring frosts, but when a successful season arrives the yield is so large that it averages up nicely for the disastrous years.

The Chester strata soils are not particularly important. They occur above the Mammoth Cave limestone soils near or at the top of the higher knobs. They are wooded, or where cleared are planted to corn and the other crops already mentioned.

The flat or gently rolling tops of some of the knobs topped by the Pennsylvanian formations have a sandy loam which has been derived from the underlying sandstone and shales. It is brown or light brown to gray in color. The subsoil varies from a heavy, fine sandy loam to a sandy clay. Fragments of sandstone are scattered over the surface and through the soil. Massive sandstone strata outcrops here and there. The sandy character of this soil and its elevated position, surrounded by steep and often precipitous slopes, causes it to drain readily. Corn is the chief crop. The steep slopes of Pennsylvanian formations have soils which support a forest growth. A large per cent of the best timber has been cut, here as elsewhere.

Along the top edges of the knobs, Mammoth Cave limestone and Pottsville conglomerate boulders have broken away from their respective cliffs and form two strips at different elevations which are so rough, rocky and steep that they are valueless except for low grade timber.

The Knobs are being robbed of their soils by water from rain and melting snow. The richest soil is washed away first. Thousands of acres have been rendered useless for agriculture by this soil erosion. It occurs on both the steep and more gentle slopes unless they are covered with vegetation. Deforested, bare slopes wash when forests and smaller vegetation would have held the soil particles in place. Farm land left bare without a cover crop, is exposed to soil wash. Such land also becomes compact and deficient in humus. This increases erosion. After a heavy rain look at the bottoms of the slopes, especially the steeper ones, and observe the rivulets running off the land. The water will be loaded with fine soil particles which it has brought down from the higher slopes. These particles contain plant food which should have gone to make trees and various farm crops.

During the mild winters that occur in the Knobs, the ground does not freeze to any great depth. It is covered with snow usually for only a few days at a time. Both of these conditions permit of soil wash throughout most of the year.

The creeks and rivers meander and cut away the fields through which they flow. They erode the convex side of their channels (concave side of the bank), and deposit sand and stones on the concave side of the channel or on the floodplain. This erosion is increased by the swiftness of the streams. Their rapidity of flow is caused by their moving from a high area to a relatively low base level within a short horizontal distance. Also there are no lakes or ponds to regulate the stream volume. Consequently the run-off is rapid after a rain or melting snow. The swifter the stream, the greater its transporting power which varies as the velocity raised to the 6th power (V^6). This soil erosion causes loss to the farmer the same as though real money had been taken from his farm. The accompanying photograph shows the effects of soil erosion in the Knobs, Plate XVIII.

The great waste of soil and the loss of money which it represents can, to some extent, be prevented. But some farmers crop their land as long as it will yield adequate returns, after which they let it lie idle and "rest," in a bare condition or

PLATE XVIII. THE "CRATER," BLUE LICK, MADISON COUNTY.

Erosion of this knob of New Providence shale has formed a crater-like depression.

covered only with such weeds as spring up. This soil is deficient in humus, becomes compact, and lacks absorptive power. With nothing to hold the soil in place and with the soil so compact that it can retain but a small amount of the rainfall, the land washes badly. It should have been planted so as to make a good pasture thereby adding humus, nitrogen and other plant foods to the soil. If used for pasture be careful that the roots are not killed by too close grazing. When not planted to cultivated crops the land should be planted to a cover crop, unless put into pasture. This cover crop when turned under will add nitrogen and humus to the soil which will increase the absorptive power. Correct rotation of crops should be practiced. Lime and drainage will help the Knob soils very much.

Cultivated land can be prevented from washing as much as it otherwise would, by deep plowing, which allows the soil to absorb more moisture thereby reducing the amount of surface run-off. A narrow strip of unplowed land left between a cer-

tain number of cultivated rows extending like a contour line horizontally along the face of the slope, helps stop loss of soil from the field. Plowing a back furrow along the hillside in the direction just described, reduces soil erosion. The rows between a clean cultivated crop such as corn, should run parallel to the crest of the hill as mentioned above. Scientific methods of forestry should be practiced. Young trees should be planted where the larger trees have been cut down. Terraces made on steep slopes tend to diminish erosion.

If gullies are commencing to form on a slope, unless stopped they soon will make the surface too rough for cultivation in addition to carrying away the soil. New gullies will develop and drain into the original one, so that in a comparatively short time the entire land surface will be ruined. As the gully deepens its bed it lowers the adjacent ground water level. This makes the crops on the area affected more sensitive to drought. To prevent a gully from continuing its growth, place brush, straw, or stones at the head of the depression. The loose material will also cause more water to sink into the ground and less to run off on the surface. If a dam is built some distance down the gully, sediment washed down from above will ultimately fill the gully on the upslope side of the dam, thereby reclaiming the land. For detailed directions write the State Agricultural Experiment Station, Lexington, Kentucky.

Clays

Kentucky clays may be classed as fire clay, pottery clay and brick clay; the last named being used for paving bricks, drain, roofing and floor tile, and sewer pipe. Fire clays are not mined in the Knobs proper but in Rowan County they are worked a short distance east of the Knob Belt. (Ref. 97:154, 156). Pottery clays have a high state of purity and physical properties that adapt them for this purpose. Residual clays suitable for brick manufacture occur in all parts of Kentucky.

The value of chemical analyses and physical tests in determining the use to which a given clay is best suited are explained by H. Ries (Ref. 97:15) as follows: "If a clay is to be used in the manufacture of burned clay products, chemical

analyses are rarely of any value because they show practically nothing regarding its physical characters. If it were known that all the substances shown by the chemical analyses were uniformly distributed through the clay and intimately blended, then it might be safe to make some deductions regarding such properties as the fusibility, and color burning quanlities, but in the absence of evidence, interpretations are not always safe.

"Perhaps one of the safest deductions to make, is that regarding a positive refractory character. That is to say, if a clay contains a low total content of fluxing impurities it may be regarded as a fire clay.

"The physical properties, which are all important in the use of a clay, must be determined separately. These properties include plasticity, water of plasticity, shrinkage, fineness, transverse strength, bonding strength, slaking test, vitrification, color after firing, and fusion."

The Knobs contain several different geological formations from which clays and shales of economic value can be obtained. The outcrops of these formations have already been described in this Report in the Chapter on "Geology of the Knobs." Some transported clays also occur. The shales which are used in the clay products industries, and the formations whose residual clays also are mined for the same purpose, given in ascending geological order, are as follows:

The Plum Creek Shale occurs in the lower portion of the Silurian formation. It does not exceed five feet in thickness which limits its usefulness.

The Osgood Shale of the Niagaran Series, Silurian System, contains the Lulbegrud and Estill shales on the east side of the Cincinnati Arch. In Jefferson County, the Osgood is not considered to be of much value for clay products.

The Lulbegrud Shale which is a subdivision of the Osgood of the western Knobs, has been defined chiefly east of the Cincinnati Arch. It is a smooth, bluish gray shale which becomes a plastic clay on weathering. It is suitable for the manufacture of brick and drain tile and the smooth portion for earthenware, but the detrimental feature is that it is seldom over 15 feet thick.

Analysis of the Lulbegrud shale near Irvine, Estill County, is as follows (Ref. 97:118):

Plasticity	Very good
Water of plasticity	30.7%
Slaking time	33 minutes
Modulus of rupture, lbs. per sq. in.	343
Air shrinkage (linear)	6%
Steel hard	1050 C.
Color after firing	Red

Fire Tests

Temperature	Fire Shrinkage Per Cent	Absorption Per Cent
950° C.	4.5	12.4
1050° C.	5.0	8.6
1070° C.	6.0	00.17
1150° C.	6.5	0.4
1190° C.	Overfired.	

The Estill Shale closely resembles the Lulbegrud shale, being a smooth, bluish gray shale which weathers to a plastic clay. In some places, it is as much as 100 feet thick. It is suitable for the manufacture of brick, drain tile, hollow blocks, and, in places, earthenware. Typical outcrops are found around Irvine, Estill County, where the Estill shale directly underlies the Onondaga limestone.

A sample of Estill shale taken from this formation near Irvine, according to H. Ries (Ref. 97:119) has the following properties:

Lime carbonate	Present
Working quality	Excellent
Plasticity	High
Water of plasticity	32.7%
Modulus of rupture, lbs. per sq. inch	474
Air shrinkage (linear)	7%
Color after firing	Red
Steel hard	950° C.

Temperature	Fire Tests Fire Shrinkage Per Cent	Absorption Per Cent
950° C.	3	9.
1050° C.	9	1.3
1070° C.	9	0.7
1150° C.	9.5	0.3
1190° C.	Overfired	

Ries states, "This is an excellent clay, and should compete with the New Providence shale, although it is somewhat less desirable on account of its higher shrinkage. The plasticity and transverse strength are good."

A 65-foot exposure of Estill shale occurs just north of Crab Orchard on the road to Lancaster (Ref. 97:3). Lewis and Fleming counties also contain large quantities of this shale. South of Olympia, Bath County, some knobs are composed almost entirely of this shale which is about 100 feet thick.

The Waldron Shale, Silurian System, occurs only on the west side of the Cincinnati Arch (Ref. 97:3). It forms a greenish clay on weathering. In Jefferson County other clays occur better adapted to the manufacture of clay products than the Waldron shale.

The Ohio and Sunbury Shales of the Devonian and Mississippian Systems respectively, are the next shales of importance. They are black, carbonaceous, fissile and on weathering first break down into small, thin plates. In this stage they are non-plastic when ground and mixed with water and are of no value for clay products. Further weathering produces an arenaceous clay of a reddish color, from which brick can be made. At New Haven, Nelson County, brick and drain tile are manufactured from the residual clay formed from the Ohio shale.

The Bedford Shale in Kentucky is not important as a source of material for clay products. It is a soft bluish shale, but may contain arenaceous material. The Bedford shale in Lewis County is 95 feet thick. The Berea sandstone of the Mississipian System as it extends south in Kentucky changes into shale. The Bedford-Berea shales near Caney Switch, Bath

County, have a combined thickness of $19\frac{1}{2}$ feet (Ref. 97:4). The Bedford shale in Kentucky is not so good as the New Providence shale for clay products.

The New Providence Shale of the Mississippian System, extends throughout the Knobs and is more extensively used for clay products than any other shale in the Knobs. It is a soft, greenish or greenish gray shale which on weathering becomes a plastic clay. The unweathered shale may easily be ground and when mixed with water is plastic.

At Junction City, Boyle County, the New Providence shale in Blue Knob is about 85 feet thick. If this shale bank were worked the product could be shipped over the Queen & Crescent, or the Louisville & Nashville Railroads.

Tests made of this shale at Blue Knob by H. Ries (Ref. 97:112), gave the following results:

Lime carbonate	None
Working qualities	Very good
Plasticity	Good
Water of plasticity	25.6%
Modulus of rupture, lbs. per sq. in.	309
Air shrinkage, linear	3.5%
Color after firing	Red
Steel hard	950° C.

Temperature	Fire Shrinkage Per Cent	Absorption Per Cent
950° C.	4.5	11.0
1050° C.	5.0	10.0
1070° C.	6.0	3.2
1150° C.	8.0	0.4
1190° C.	Overfired.	Slightly swelled

"This clay is of a type," states Ries, "that should make good brick, or hollow block. It might also be used for common red earthenware. It is similar to the clay used at Firebrick, Lewis County, for paving blocks."

At some places in Jefferson County, such as Coral Ridge, Plate XIX, the New Providence shale is used to manufacture various clay products. Analyses of this shale at Coral Ridge is given on pages 195-196 of this Report.

About six miles southwest of Louisville, a bank of New Providence shale 75 feet high occurs near the Illinois Central Railroad and is favorably situated for transportation.

PLATE XIX. PIT OF THE CORAL RIDGE CLAY PRODUCTS COMPANY, JEFFERSON COUNTY.

The New Providence blue and green shales form the face of the pit.

At Firebrick, Lewis County, the New Providence shale is used to make paving blocks. It is here similar to the shale of this formation mined at Coral Ridge, and to that occurring near Junction City.

About two and one-half miles northeast of Berea, Madison County, occurs a small knob composed of New Providence shale. It is gray in color and very smooth. This knob, Plate XVIII, locally is known as the "crater," on account of its volcanic shape which was caused entirely by erosion. Blue Knob near Junction City, already mentioned, is called in that vicinity a "volcano." But it should be remembered that these shale knobs have no relationship whatsoever to volcanic forces. They were carved by the same action of rain water and surface wash as can be seen taking place nowadays after any rain, upon their slopes.

Taken as a whole, the New Providence shale is used for clay products more than any other shale formation in Kentucky. From it are manufactured brick, hollow blocks, paving blocks and common red earthenware. At a number of places in the

Knobs, the New Providence shale is favorably situated for mining and transportation, and awaits development.

The Rosewood Shale is separated from the underlying New Providence shale by a sandstone formation. According to Butts, it forms the main body of the Knobs south of Louisville; and in Bullitt County at West Point its upper portion is about on a level with the railroad. Between Kathryn Station and the north side of Moremens Hill, along the Louisville, Henderson & St. Louis Railroad this shale is said to occur in large quantities. At certain horizons, it contains a good many iron carbonate concretions. It is not considered by Ries to be as good as the New Providence shale for clay products; but it has a good plasticity and fires to a red color. The Rosewood shale may be used for bricks and hollow blocks.

The Pennington formation of the Chester Series, Mississipian System, contains a plastic shale where it outcrops near the top of Bear Mountain southeast of Berea, Madison County. It is said to fire to a red color. Due to its high elevation where it can be reached only by a long haul over a very poor road, this shale bank will not be of economic importance.

The Pottsville formation of the Pennsylvanian System contains fire clay in Rowan County but not in the Knobs proper.

The Irvine formation, Tertiary age, contains clay which is mined near Waco and Bybee, Madison County, where it is made into art pottery and other products. The properties of the light gray Waco pottery clay coming from the Irvine formation are given by Ries (Ref. 97:138) as follows:

Working qualities	Very good
Plasticity	Very good
Water of plasticity	26.3%
Modulus of rupture, lbs. per sq. in.	678
Air shrinkage (linear)	5%
Color after firing	Reddish buff
Steel hard	950° C.

Temperature	Fire Shrinkage Per Cent	Absorption Per Cent
950° C.	3.5	4.6
1050° C.	5.0	4.8
1090° C.	5.5	3.5
1130° C.	6.0	0.4
1190° C.	7.5	0.1
1250° C.	7.5	0.1

Residual clays of comparatively recent age formed by the weathering of limestone formations, are found in all parts of the State and ordinarily are used to make building brick. In Jefferson County residual clay from the Jeffersonville limestone is plastic, red burning, and is used for brick and drain tile.

Alluvial clays having properties suitable for the manufacture of clay products, are found along some of the river valleys. For example, somewhat east of Stanton, Powell County, on the Lexington & Eastern Division of the Louisville & Nashville Railroad is a brick plant which obtains its clay from the Red River Valley. Only two or three inches of the top soil are stripped to reach the desired clay. The excavation is about fifteen feet deep. The clay used is plastic and smooth.

Near Clay City, Powell County, along the Red River occurs an alluvial clay six feet thick with two feet of overburden.

Just east of the Knobs proper, in Rowan County, occur fire clay deposits which have been worked at Haldeman; and on Christy Creek, five miles southeast of Morehead. Geologically these fire clays lie between the Mississippian and Pennsylvanian formations. At Haldeman they are worked by drifts driven into the hills to the clay bed, connected by cross entries, Haldeman clays are flint clay, semi-hard clay, and No. 2 plastic clay (Ref. 97:214).

Gravel and Sand

Gravel used for surfacing the public roads occurs in the Knobs. A quartz gravel is obtained from some stream-beds, especially if these streams rise near the Pottsville conglomerate areas where pebbles from this formation go to make up a portion of the creek's load. A siliceous gravel also is obtained by

streams that pass over the Waverly formation, the load being dropped along the floodplains or meander curves. Residual gravel from the Pottsville conglomerate can be secured in certain localities, but if in situ, it will be high up on the knobs. This may necessitate a long haulage to the valleys below; an advantage, however, being that the loaded wagons go down grade, while the empty wagons are returned up the slope.

The glass sand district of Olive Hill extends from Carter County into Rowan County, but by the time Farmers, Rowan County, is reached, the typical white and yellowish white sand stone, so suitable for glass manufacture, has been largely removed by disintegration and erosion. From Louisville northeast along the Ohio River for ten miles or more, sand has been deposited by the river on the border of the Knob area. This sand also occurs southwest of the city. It is a yellowish white sand, sharp, angular, and contains some mica scales. It makes a good building sand. After passing through a 60 mesh sieve, this sand is nearly pure white, crystalline quartz; and when washed, dried and screened, would be a good glass sand, according to a statement of Dr. Charles H. Richardson (Ref. 95:76, 91).

Building Stones

The Knob counties contain sandstone and limestone formations which are suitable for buildings, sills, columns, interior decoration, foundations, abutments, piers, culverts, road metal, railroad ballast, lime, natural cement, Portland cement, agricultural lime, and many other purposes.

Quarries and rock formations in the Knob Belt, itself, will be described in the present report; the stone industry outside of the Knob formations, even though within Knob Counties, being omitted. For details regarding all quarries in Kentucky see the Kentucky Geological Survey Report, "Building Stones of Kentucky," by Prof. C. H. Richardson.

Bath County. The Buena Vista sandstone of the Cuyahoga formation occurs near Olympia Springs. It is rather thin bedded, however, and its use would be local (Ref. 94).

At Caney Switch the Buena Vista is twelve feet thick. It is a fine grained, even textured, gray sandstone. The individual beds are separated by thin layers of soft, bluish shale. Care should be taken in choosing this sandstone for building purposes to see that it does not contain iron compounds which would disfigure the stone on weathering.

Gray limestones have been quarried and used locally somewhat west of Owingsville.

Bullitt County. Quarries of limestone and sandstone occur in this county at several points. A limestone is quarried near Shepherdsville, sandstone near Belmont and light gray limestone at Quarry Switch on the Louisville & Nashville Railroad. Quarries also occur near Clermont and Stites (Ref. 94).

Estill County. Minerva Mountain near Irvine is composed of strata ranging in age from the Ohio shale at the base to St. Louis limestone at the summit. In the Upper Waverly here exposed is 24 feet of a massive, buff colored, argillaceous sandstone which Richardson believes could be used locally as a building stone.

A Sub-Carboniferous limestone which occurs near Cottage Furnace, according to the same authority, contains beds of suitable thickness and quality to furnish a good building stone. This limestone is gray, fine grained, granular and siliceous.

Lithographic stone occurs in Estill County.

Fleming County. Numerous quarries occur in this county. In the Knob Belt a red sandstone quarry is situated just east of Hillsboro. Several other quarries are in the same red sandstone. There are also quarries in the limestones of the Bluegrass portions of this county.

Jefferson County. Quarries occur in the Louisville limestone of the Silurian age on Beargrass Creek. This formation varies from 60 to 75 feet in thickness. Individual beds are one to seven feet thick. The upper portion is bluish gray, fine grained, even textured, siliceous (cherty), and argillaceous. It is highly fossiliferous, being the principal source of the Louisville limestone fossils. Near the middle portion of this formation is a thick, even bedded, bluish-gray, magnesian limestone which is an important building stone and also is used for foun-

dations, curbing, and other purposes. The lower portions of the Louisville limestone are darker gray than the upper beds and are harder than other parts of the formation. These harder beds are said to make better curbing, flagging, paving blocks, and macadam than can be obtained from the overlying strata. The cherty layers of the Louisville limestone sometimes are used in foundations, but of course they are not often chosen to be used in the main portion of the building.

The Laurel dolomite of the Silurian, comes below the Louisville limestone, the two formations being separated geologically by the Waldron shale. The upper half of the Laurel dolomite makes an excellent building stone. It is fine grained, even textured, and of a uniform light gray color when quarried. It weathers a buff color. The individual beds are one to two feet thick. The lower portion of the Laurel dolomite is harder and darker in color than the upper part. These lower strata are suitable for foundations, curbing, paving and macadam.

Outside of the Knob Belt the Saluda limestone is used for heavy masonry work. Other Ordovician limestones are quarried for various purposes.

The Kenwood and Holtsclaw sandstone of the Waverly series, according to Butts (Ref. 11:211) should afford building stone for local use.

The Louisville limestone, Laurel dolomite, and, to a less extent, the Saluda and Waynesville limestone are quarried, crushed and used for road metal. Laurel dolomite is shipped from the Tucker Quarry, Tucker, Jefferson County, this quarry being on the Louisville & Lexington Branch of the Southern Railroad. Permanent quarries are worked in Louisville, and local and temporary quarries are opened in the limestone beds near stretches of road which are being metaled. The ease with which limestone can be secured for the roads throughout Jefferson County has aided greatly in giving to this county its excellent highways.

The Jeffersonville limestone in Jefferson County is suitable, at least in certain areas, for the manufacture of lime. Where used to make lime, it must not have over five per cent of impurities, such as silica, alumina and iron oxide.

The composition of the Jeffersonville limestone is also satisfactory for the manufacture of Portland cement according to Charles Butts (Ref. 11:218, 219), but "the Louisville limestone and Laurel dolomite contain too great a proportion of magnesian carbonate for use in Portland cement, which does not admit a magnesian carbonate content exceeding five per cent for the best quality of cement." The Jeffersonville limestone is 20 feet thick and underlies sufficient territory to be of economic importance both for lime and Portland cement where its chemical composition adapts it for either of these uses. This limestone is also suitable for the manufacture of agricultural lime.

The Silver Creek limestone, probably not over ten feet thick, underlies the city of Louisville. In earlier days it was used as a natural cement. The quarry was at the foot of Fourteenth Street near the Pennsylvania Railroad bridge. This formation is not of much economic importance owing to its thinness, limited extent, unfavorable position for quarrying, and the fact that natural cement is not used so extensively as formerly.

Lewis County. Several sandstone quarries were operated near Vanceburg during and shortly after the Civil War, according to Prof. Thomas W. Rowland of Vanceburg. He states that in 1861 a quarry in the Berea sandstone was started on Town Branch, about two miles from Vanceburg. The company had a mill at this point where the stone was cut. The stone was then lowered to barges on the Ohio River. It was floated down to Cincinnati where it was re-sawed and shipped to Chicago, St. Louis and other points. Another successful quarry for those days was opened on Rock Run about five miles southeast of Vanceburg. It was owned by a Mr. Finnigan. The stone was hauled to Vanceburg on large wagons having wheel-rims six inches wide, drawn by ten and twelve yoke of oxen. These wagons were named, three of them being called the Condor, the Ajax and the Boaz.

Recent examination of the formations of the Knob portion of Lewis County shows Berea sandstone 22 feet thick in the knob called Alum Rock at Vanceburg. This stone is thick bedded, medium grained, gray, and ripple-marked. These ripple-marks

serve to identify the Berea sandstone in this region. Weathered surfaces are somewhat stained with iron. The Berea sandstone also outcrops along the Ohio River at other places in this area. This sandstone from Lewis County has been used for building-stone, bridge work, foundations and similar purposes.

Sandstone from Kinney Hill quarry, four miles southwest of Vanceburg, on the Kinniconick Branch of the Chesapeake & Ohio Railroad has been used extensively. The beds are one to two feet thick (Ref. 94).

Limestone can be secured in Lewis County that is suitable for construction purposes, road metal, and the like. There are fifteen sandstone and limestone quarries in Lewis County.

Lincoln County. Four quarries occur in this county, the stone being used for foundations and road metal. Prof. Richardson describes a limestone, or marble ledge, two miles east of Crab Orchard as follows: This stone is well crystallized and is fourteen feet thick at the outcrop. It "would take a very high polish and make a beautiful stone for both massive construction and decorative interior work. There is also near Gilberts Creek a pink marble traversed by dark zigzag bands closely resembling the pink Tennessee marble. This rock is fine grained, well crystallized and good for both building and monumental work."

Madison County. Limestones of the Silurian, Devonian, and Mississippian formations have been used for road material.

An abandoned sandstone quarry in the Waverly formation occurs south of Berea near the Louisville & Nashville Railroad.

The Ohio shale is used on some of the public roads but it is not satisfactory. The Knob limestones have been quarried and used for road metal and railroad ballast. Weathered Pottsville conglomerate is quarried, crushed and screened for sand and gravel, on Indian Fort Mountain, near Berea.

Montgomery County. A sandstone quarry occurs on the Spencer Pike six miles east of Mt. Sterling. This stone is buff to yellow, the beds ranging from eighteen inches to three feet in thickness. It is used for abutments, foundations, and the like. Numerous other quarries occur in this county outside of the Knob area (Ref. 94).

The Pottsville conglomerate occurs in large quantities in Pilot Knob which rises about nine miles south of Mt. Sterling. This conglomerate could be used for gravel and other purposes.

Nelson County. A quarry occurs at Bardstown, the top rock being a sandstone 2 to 3 feet thick beneath which is 9 to 10 feet of gray limestone. The sandstone is used in retaining walls. It is said that good building stone also can be obtained here.

Several limestone and sandstone quarries occur west of Bardstown and limestone quarries east of the town. Near New Haven on the Louisville & Nashville Railroad a gray limestone is quarried. Limestone quarries also occur near Deatsville, Bloomfield, and New Hope. The stone is used for buildings and road metal (Ref. 94).

Oldham County. The Niagaran limestone at LaGrange was quarried for bridges, curbing, foundations and the like. Some of the limestones outside of the Knob formations are suitable for building purposes.

Powell County. Morris Mountain about three miles north of Stanton contains 63 feet of massive, argillaceous, buff colored sandstone with shaly layers in the lower portion, according to Prof. Richardson. Certain beds of this sandstone, he believes, "should make a fairly satisfactory building stone for local use only."

Near the top of this mountain, Mississippian limestone outcrops. The upper portion of this limestone, states this authority, is "apparently commercial." The lower portion weathers a yellowish color. The Gasper oolite and the Ste. Genevieve limestone are at the top of this knob.

Rockcastle County. This county contains 12 limestone and sandstone quarries, but they generally occur east of the Knob Belt proper. The limestone is sold for railroad ballast, road metal, agricultural lime, cement, foundations and curbing. Some of the Mississippian limestone takes an excellent polish and could be used for building purposes and decorative interior work. The sandstones quarried are fine grained, even textured and gray in color. Richardson considers the sandstone from

the Langford quarry four miles north of Mt. Vernon as "well worthy of an interstate reputation as a building stone."

The Wildie quarry sandstone, sometimes called Rockcastle Freestone, has the same general characteristics as the Langford quarry stone, states the authority quoted above.

Rowan County. Three important quarries occur in the Buena Vista member of the Cuyahoga formation. They are located at Farmers, Freestone, and Bluestone.

The sandstone is even-bedded and even-textured, fine grained, of medium hardness, and gray to bluish gray in color. Because the stone splits easily in all directions, it is called Rowan County Freestone. It is readily dressed or sawed. The bottom layer of the Buena Vista is known as the "City Ledge," presumably because this layer was quarried at Buena Vista for use in Cincinnati. Near Rockville the "City Ledge" is 2½ feet thick. The sandstone layers of the Buena Vista are separated by shale partings which aid in quarrying the sandstone. Care should be taken in selecting this stone to avoid iron discolorations which may appear on weathering. The Buena Vista sandstone is used for road ballast, bridge piers, abutments, flagging, sills, steps, columns, and other building purposes, also for monument bases. Mills located at each of the quarries mentioned above, saw and turn the sandstone into the desired shapes and sizes. The Rowan County Freestone Company prepares its sandstone for road foundations by dropping upon the sandstone block an iron ball weighing 2,200 pounds. The height from which this weight is dropped varies from 5 to 15 feet depending upon the thickness of the sandstone block. A new mill is being erected at this quarry.

The Bluegrass Quarries Company near Rockville Station, and the Kentucky Bluestone Company, Inc., at Bluestone, have mills with gang saws fed with silica sand for cutting the stone into the required sizes.

The total number of limestone and sandstone quarries in the Knob counties as a whole as compiled from C. H. Richardson's "Building Stones of Kentucky" is as follows:

County	No. of Quarries in the County
Bath	3
Boyle	10
Bullitt	5
Clark	18
Estill	1
Fleming	24
Garrard	2
Jefferson	18
Lewis	15
Lincoln	4
Madison	4
Marion	16
Montgomery	25
Nelson	17
Oldham	1
Powell	1
Rockcastle	12
Rowan	4

It will be seen from the descriptions given above that the Knob Belt contains large and widely distributed areas of limestone and sandstone formations which are suitable for building stone, foundations, piers, abutments, road metal, railroad ballast, lime, Portland cement, agricultural lime, and numerous other purposes. Great areas of rock, excellently adapted to one or more of these uses, still lie undeveloped. Stone is therefore another economic resource of the Knobs which has enormous potential possibilities for the enrichment of the citizens of this physiographic division of Kentucky, as well as for the state as a whole.

Coal

The Pennsylvanian formations occur in portions of the eastern Knobs; and a tongue of Pottsville extends out from the main mass of the Pennsylvanian strata of the Western Coal Field of Kentucky into the southern Knobs of Marion and Taylor counties. Patches of Pottsville conglomerate continue across Lincoln County. This strip of Pottsville indicates that the Eastern and Western Coal Fields of Kentucky were once united.*

*Burroughs, W. G., A Pottsville Filled Channel in the Mississippian. Ky. Geol. Surv., Series VI, Vol. 10, pp. 115-126, 2 sections, and map.

In the southern and eastern portions of the Knobs, the Pennsylvanian is nearer to the edge of the Bluegrass and some of the higher knobs are capped by Pottsville formations consisting of the basal conglomerate, overlain by standstones and shales containing a seam of bituminous coal about 12 to 30 inches thick near the bottom of the Pottsville. Bear Mountain, Madison County near the Rockcastle line has near its top about ten acres of this interconglomerate coal. The outcrop is covered. A drift was driven into the side of the mountain to the unweathered coal. The seam near the entrance to the drift is badly weathered, and at present a part of the roof has fallen breaking the timbers which formerly supported it. The seam where mined is said to be from 24 to 30 inches thick. This was a wagon mine and never of much importance. The coal was hauled over the rough, steep trails to the Dixie Highway about 500 feet vertically below the mine. This working is now abandoned; and only very high prices for coal can make it a paying investment. Coal occurs near the Knobs border in Rockcastle County.

Coal is actively mined at Big Hill on the border of Madison and Jackson counties where the Eastern Mountains of Kentucky come in contact with the Knobs. The mines, which are small, are more in the Mountain section than in the Knobs. The coal is at the same horizon as the seam described as occurring on Bear Mountain. It is about 24 to 30 inches thick and is mined by drifts. This coal is sold locally and in Berea to which town it is hauled by wagon.

Estill County contains some coal bearing strata in the Knobs. A seam 20 inches thick occurs in the ridge between Red Lick and the headwaters of Drowning Creek, as already stated by A. M. Miller (Ref. 80:44). Just east of Station Camp Creek a coal bloom occurred near the bottom on the Pennsylvanian.

Rowan County has coal which is locally from 12 to 36 inches thick (Ref. 36). Broadly considered coal is a very unimportant mineral resource of the Knobs.

Oil and Gas

The commercial oil bearing formations of the Knobs are the Onondaga of the Middle Devonian and the Niagaran of the Silurian System. Beneath the Niagara, geologically, in descending order are found "oil sands" that produce some oil in other parts of the State but which are not important in the Knobs, these formations being as follows: Upper Sunnybrook (Upper Ordovician), Trenton (Middle Orodovician), Calciferous (Lower Ordovician) as a possible source of gas, Knox Dolomite (Cambro-Ordovician). Commercial pools of oil or gas should not be sought geologically above the Ohio shale (Devonian), in the Knobs proper, although the drill may start in the Mississippian or Pennsylvanian and penetrate to the Onondaga or Niagara. The reason is that, although the Knobs contain strata that in other parts of the State are oil producing, erosion has isolated the Mississippian and Pennsylvanian formations into hills where the edges of the formations outcrop. Any oil or gas that these rocks might contain would have escaped at the outcrops, for the knobs are of no great horizontal extent.

Oil is secured from the Niagaran in the Knobs in the counties of Bath, Rowan, Powell; and outside the Knobs in other areas. The Onondaga limestone furnishes oil in Bath, Rowan, Powell, Estill, Lincoln, and in small quantities in several other Knob counties; and in districts outside of the Knobs.

In prospecting for oil in the southern Knobs and adjacent territory, it should be remembered that across the crest of the Cincinnati Arch for about 40 to 50 miles there is a great unconformity. In this region occurs places where the Ohio black shale rests upon the Ordovician, the Niagaran and Onondaga formations being absent. If oil is present, it will usually be in the Ordovician; but there may be patches of Niagaran or Onondaga within the area that would serve as reservoirs for oil and gas.

The Ohio shale in Kentucky has not yielded any commercial oil or gas, except in Meade and Floyd counties, where gas has been obtained from a sandy lens in this shale.

Kentucky oils usually are green in color and have a gravity ranging between 32 and 38 degrees Baume′. The "Ragland" oil from Bath County, however, is blackish and runs as low as 22 degrees Baume′.

The important oil and gas fields of the Knobs, some of them extending into adjacent territory, are: the Ragland Oil Pool in Rowan and Bath counties; Olympia Oil Pool, Bath County; Irvine Oil Pool, Estill County; Station Camp Oil Pool, Estill County; Lincoln County Oil Pools. The geographical locations of these pools are shown on the State geologic map.

The Ragland Oil Pool extends into parts of Bath, Rowan and Menifee counties, crossing the meander curves of the Licking River. Its long axis runs in a northeast-southwest direction. The oil which is blackish and has a gravity as low as 22 degrees Baume, is secured from the Onondaga limestone at depths varying from 188 ft. to 842 ft., 953 ft. and over. The pool has a monoclinal structure. It was discovered in 1900, but is now becoming exhausted.

The Olympia Oil Pool is located in southeastern Bath County. It covers only a small area. The oil formation is the Onondaga limestone.

The Irvine Oil Pool, Estill County, is one of the most important oil and gas sections so far developed in the State. It is located a short distance northeast of the town of Irvine. Briefly the history of this pool is as follows: Oil and gas were discovered about 65 years ago, 10 miles northeast of Irvine. As long ago as 1878, oil was known to occur at Irvine. The Ravenna oil field, which lies one to three miles south-southeast of Irvine in the valley of the Kentucky River and on the hillsides, was first drilled in in 1901. The Onondaga limestone, Plate VIII, which is the oil bearing formation, is struck at a depth of from 75 to 111 feet when the wells start in the Ohio shale of the valleys. The Onondaga averages about 20 feet in thickness; the pay streak being near the top. This Ravenna oil pool was abandoned in December, 1911. Early in 1915 oil was struck at 200 feet on Tick Fork, a few miles northeast of Irvine. The well started in the Waverly formation and ended in the Onondaga limestone. Renewed drilling ensued and the Irvine and nearby oil pools

were developed. The Irvine Oil Pool proper is about nine miles long by one to two miles wide. It extends from the Knobs into adjacent mountain territory. The oil is dark green by reflected light. Its gravity ranges from 30 degrees to 36 degrees Baume. The gasoline content is high. Production is from the Onondaga limestone. The oil bearing portion of the formation differs from the rest of this dolomite in having larger pore spaces and in being softer. The distance of the "pay sand," below the top of the Onondaga is said to vary in different parts of the field. Gas has been found in some wells, while other wells yield little or no gas. The structure of the region is that of an anticline associated with a gravity fault. Oil is found in the anticline on the southern side of the fault.

Few of the oil wells in the Irvine Pool flowed oil naturally. The initial production is said to vary from 5 to 200 barrels a day. The initial pumping capacity of the wells, according to E. W. Shaw (Ref. 109), was generally between 10 to 70 barrels a day. The depth of the wells is from 94 feet to 788 feet and slightly over. The Cumberland pipe line extends into Estill County and serves this and other pools.

The Station Camp Oil Pool is located about five miles south of Irvine, Estill County, on Station Camp Creek. Production is from the Onondaga limestone. The structure is anticlinal. Starting in the valley, the total depth of the wells is said to vary from about 167 feet to 359 feet. Plate XX shows one of these wells being shot. Faulting has affected the accumulation of oil and gas in this district. In prospecting for oil the faults as well as the anticlines and monoclines should be noted carefully.

In the southeastern, mountainous part of Estill County is the Ross Creek Oil Pool. It is a small oil pool located on an anticline. Petroleum is obtained from the Onondaga limestone.

The Lincoln County Oil Pools are located on Buck Creek and on Green River (Ref. 56:152). Production is secured from the Onondaga limestone. The structure is anticlinal. Oil is struck at shallow depth. Pipe lines lead from each of these pools to tank car stations on the Queen & Crescent Railroad.

Oil production is obtained in lesser quantities in the following Knob counties. A number of five to ten barrel wells

PLATE XX. SHOOTING AN OIL WELL, STATION CAMP OIL POOL.

have been drilled in Lewis County. Gas and a showing of oil in the Onondaga has been struck on anticlinal structure a short distance south and also east of Berea, Madison County. These shallow wells start in the Ohio shale of the creek valleys. Development has not gone far enough to determine how much oil these wells will yield. Oil has been found in a few wells in Montgomery County. Powell County contains several oil producing areas near the Knobs. The Ashley Pool, Powell County, was developed in 1917, oil being found in the Onondaga limestone. This production occurs on a fold along the Irvine-Paint Creek fault, according to Dr. W. R. Jillson, State Geologist (Ref. 56:166). The southern end of the Menifee Gas Field extends into the northern portion of Powell County. Oil and gas have been found in Rockcastle County, but no pool of commercial importance has been discovered to date.

Doubtless more oil pools will be found in the Knobs as prospecting progresses. There are favorable Knob areas yet unprospected that are underlain with the Onondaga limestone, the greatest oil producing formation in Kentucky up to the present time.

An oil mine, shown in Plate XXI, is being developed at the north end of Sixth Street, Ravenna, Estill County, by the Ravenna Oil and Products Company. A shaft was started on a terrace of the knob that rises to the north of this location, in the New Providence shale and sunk through the New Providence and Ohio shales into the Onondaga limestone. This shaft is 8 by 16 feet at the top, about 6 by 10 feet at the bottom, and 131 feet deep.

It is proposed to excavate a room, 20 feet by 40 feet, in the limestone at the bottom of the shaft, states Charles E. Kimball, Chief Engineer, the floor of this room being lower than the oil "sands" of the limestone. With a diamond drill, holes are to be bored up the dip into oil "sands" following the strike of the "sands." The oil, it is believed by the operators, will run into these holes and flow down into a sump cut in the floor of the room at the bottom of the shaft. From the sump the oil will be pumped to the surface. Plans for more extensive operations were described by Dr. W. R. Jillson (Ref. 61:149).

The plant is fully equipped with mining machinery necessary for carrying on this experiment. They also have a demonstration oil shale retort and propose ultimately to extract oil from the Ohio shale.

PLATE XXI. AN OIL MINE.

Property of the Ravenna Oil and Products Company, Ravenna, Estill County. Power plant shown on the left, shaft located inside the stockade shown in center of the photograph.

Natural-gas-gasoline has been obtained from wells in Estill County.

Oil Shale

The petroleum accumulations of the United States are now generally regarded as comparatively short lived. At the present time this country uses more petroleum products than are obtained from petroleum produced within its own boundaries. Enormous quantities of oil are imported from Mexico and other countries. The foreign oil fields will not continue to yield abundantly forever. The United States must ultimately depend upon some other source for its petroleum products, or use substitutes.

Scotland has been the pioneer in developing a process to solve the problem which will arise with the exhaustion of liquid petroleum. About 1860, oil was first distilled in Scotland on a commercial scale from bituminous shale. The industry con-

tinued. In 1871, the output of oil shale was 2,350 long tons; 1917, 3,116,529 long tons. France also entered the oil shale industry but it did not flourish there as in Scotland. This latter country has shown that with all the technical and economic factors favorable, the oil shale industry can be carried on with success. These favorable factors as they occur in Scotland are: cheap processes for treating the shales and oils produced from them, competition only with high priced petroleum products, low labor costs: an extensive, nearby market for the oil and by-products.

Oil shale contains little or no liquid petroleum. But it does have bituminous substances; and when placed in a retort and subjected to destructive distillation, yields gas, crude oil, and nitrogen compounds. Among these compounds is ammonia which is given off in solution in water. The ammonia water is distilled and the ammonia gas passed into sulphuric acid forming ammonium sulphate. The crude oil is refined to produce various petroleum products. The residue left after the shale is distilled is waste unless some economic use can be devised. It comprises about 75 per cent of the original weight of the raw shales; the exact per cent varies.

Dr. W. R. Jillson has described the possibility of using the residues from the distillation of oil shale in the manufacture of Portland cement. Analyses, he states, show that the residue is not suitable immediately for this purpose. "It is possible, however, that this residue might be used in combination with additional siliceous material so as to balance the ratio of the alumnia and iron oxide to the silica properly. The ratio as it stands in the residues remaining after the burning is too low. Another way to state it is to say that the silica is deficient as compared to the alumina and iron" (Ref. 55:25).

Oil shale in the United States is found in Colorado, California, Utah, Nevada, Wyoming, Ohio, Indiana, Tennessee, Kentucky. The Rocky Mountain oil shales distill 42 to 80 gallons of oil per ton of oil shale; and even slightly higher yields have in places been obtained. Oil shales of the Eastern States distill from 8 to 30 gallons per ton; but their occurrence nearer a market somewhat offsets the lower yield.

In Kentucky the great oil shale formations outcrop chiefly in the Knobs. They are the Sunbury and Ohio shales. The Sunbury at Vanceburg, Lewis County, is 16 feet thick, but in Powell County it is only four feet thick. With the disappearance of the Bedford-Berea formations in Estill County, the Sunbury comes down upon the Ohio shale. The Ohio shale varies from 25 to 245 feet in thickness. It outcrops throughout the Knob Belt, and underlies thousands of acres in Kentucky. Large areas, however, must be discarded because they are too badly weathered to be of value as oil shale, and also away from the outcrop the overlying formations become too thick for economical stripping. Dr. W. R. Jillson allows approximately 1,000 feet from the outcrop as the outside limit of stripping. His estimates of the areas of Ohic shale which are workable and areas not workable are as follows:

Computed Areas of Ohio Black Shale in Kentucky (Ref. 55:4).

Section	Area of Outcrop		Area Not Workable		Area Workable ⅕ Mi. Beyond Edge of Outcrop		Sectional Totals Workable	
	Sq. Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Western*	511	327,040	128	81,920	54	34,560	437	279,680
Eastern†	365	233,600	91	58,240	61	39,040	335	214,400
Southern‡	142	90,880	35	22,400	74	47,360	181	115,840
Totals	1,018	651,520	254	162,560	189	120,960	953	609,920

* Area west and northwest of Stanford.
† Area east and northeast of Stanford.
‡ Area generally south and southwest of Stanford including a part of the Cumberland River Valley and adjacent water sheds.

The eastern and western sections given above are in the Knobs. The southern section extends outside of the Knobs.

Oil shale from 21 counties have been tested. The results as stated by Dr. W. R. Jillson are here given. Knob counties are starred (Ref. 55:7, 9):

TESTS OF KENTUCKY OIL SHALES.

County	Specific Gravity	Weight of 1 Cu. Ft., Lbs.	Oil Gal. Per Short Ton	Approx. Gas, Vol. Per Short Ton Cu. Ft.
Bath*	2.246	136.79	11.25	3,000
Boyle*	2.363	147.26	11.00	5,000
Bullitt*	2.367	147.51	11.5	8,000
Casey	2.112	131.56	18.0	8,000
Clark*	2.260	140.77	11.0	5,000
Elliott	1.968	122.59	17.25	10,000
Estill*	2.027	126.26	22.00	10,000
Fleming*	1.966	122.62	21.5	10,000
Garrard*	2.073	129.00	21.0	10,000
Jefferson*	2.198	136.78	15.5	5,000
Lewis*	2.320	144.51	10.25	3,000
Lincoln*	2.123	132.24	15.5	8,000
Madison*	2.047	127.50	18.5	8,000
Marion*	2.127	132.50	16.0	8,000
Montgomery*	2.078	129.44	19.0	8,000
Nelson*	2.126	132.43	19.0	8,000
Powell*	2.406	149.85	16.75	8,000
Rowan*	2.261	140.82	12.5	8,000
Rockcastle*	2.400	149.47	8.0	3,000
Taylor	1.964	122.43	27.75	10,000
Webster	2.197	136.92	8.25	5,000
Average, 21 samples	2.173	129.37		

November 30, 1920. Alfred Peter.

Samples from Elliott and Webster counties were not from the Ohio shale but were taken from the Pottsville formation.

The above tests of Kentucky oil shale show that the best results in the Knobs are obtained from Black shale of Estill County which yields 22 gallons of oil per ton of shale; the poorest yield was from Rockcastle County at 8 gallons per ton. Outside of the Knobs, Taylor County led with 27.75 gallons of oil per ton of shale.

Actual distillation of Kentucky oil shales for commercial uses was made at Vanceburg before oil had been secured ex-

tensively from drilled wells. The Sunbury shale was utilized. Within the last few years, several corporations have been formed to develop the oil shales of the Kentucky Knobs.

An oil shale plant should be located near a stream to secure an ample supply of water. And to be successful the oil shale operation necessitates efficient mining, mechanical and chemical engineering, and business organization. It requires a high degree of technical skill and experience in the oil shale industry, research to adapt the process of distillation and other details to the special requirements of the particular shale being used; and large sums of money properly to finance the company. All operations, including labor, must be cheap. Transportation facilities for the supplying of the plant with material required for operation, and for carrying the oil and by-products to market, must be adequate and freight rates low. There should be a large, readily accessible market for the company's products, which must be sold for the same or less price than other petroleum products of equal quality. Thus a successful, commercial oil shale plant is an entirely different proposition from the laboratory distillation of oil shale in a small retort.

A successful oil shale plant, however, will benefit not only the stockholders but also the community and the State. Large sums of money will be expended for the erection and operation of the plant and shale mines and quarries. Much of this money will be spent in Kentucky. Also, miners and other employees will settle at the oil shale works. They will purchase their goods within the State. Railroad lines will be extended to the oil shale districts, thereby opening up regions at present some distance from railroads. All of these developments will occur in the not distant future. In 1923, the oil shale industry in the United States as a whole and in Kentucky in particular is in the pioneer stage.

Iron Ore

The mining and smelting of iron ore formerly was an important industry in the Knobs. At present, it has ceased to be carried on, due chiefly to competition of the high grade iron ores of the Lake Superior District and other regions, although

additional factors also aided in the decline of the Kentucky iron industry. In the future when the high grade ores of the other states have become exhausted, these lower grade ores of Kentucky once more will become of economic value and will be utilized.

In colonial times a deposit of siderite and of limonite formed from the weathering of the iron carbonate (siderite) occurred on Slate Creek, southeast of the present town of Owingsville, Bath County. It was a replacement in the Onondaga limestone. This deposit, known as the Preston Ore Banks, was the first iron ore worked in Kentucky. The first furnace, called the Slate Creek Furnace, was conducted to smelt this ore about 1790 by Thomas D. Owing (Ref. 82:308). It ceased operations in 1838.

A forge was built further down Slate Creek and the iron, smelted in the furnace, was made into various articles. In 1814, states A. M. Miller (Ref. 82:309), cannon balls about 4 pounds in weight were cast at this plant, hauled by wagon to Licking River, and shipped by water down the Licking, Ohio and Mississippi rivers to New Orleans, where they were used against the British in the Battle of New Orleans.

The iron ore deposit here described was worked at various times until in 1880, a company organized by Prof. N. S. Shaler began to mine the property (Ref. 82:309). The ore was shipped to Ashland to be smelted. Mining stopped only with the exhaustion of the iron ore deposit.

The iron mining industry in Bath County, states Prof. A. M. Miller, then shifted to Rose Run, about 5 miles northeast of Olympia. The mine was served by the Chesapeake & Ohio Railroad which ran a spur to the pit. The ore is oolitic hematite of the Clinton, Silurian age. The deposit averages about three feet in thickness and was 33 per cent to 40 per cent metallic iron. Due to lime carbonate mixed with the ore, the metallic iron content often ran as low as 20 per cent. Mining operations ceased a few years ago (Ref. 82:311).

Other iron ore deposits formerly worked in Bath County were a nodular iron ore of the Lower Waverly formation, which was mined and smelted at the Caney Furnace southeast

of Salt Lick, southeastern part of the county; and a limonite ore which occurred in erosion hollows on the top of the Mammoth Cave limestone and was overlain by the Pottsville conglomerate, south of Salt Lick. This latter ore was smelted at the old Bath Furnace (Ref. 82:312).

An iron ore similar to the last one mentioned above occurred in the divide between the Kentucky and Red rivers.

A furnace and forge were built about 1806 where Clay City now stands. It was dismantled about 1830. Estill Furnace then was constructed where now is situated Furnace Post Office. Transportation to and from Estill Furnace, and Cottage Furnace on the same ridge (Ref. 82:312) was by wagon. A rolling mill was erected in 1837 where now is Clay City, Powell County.

In 1865 "The Red River Iron Manufacturing Company" was chartered and organized with a cash capital of $1,000,000.00, which sum was actually expended in the purchase of all the estate belonging to the Red River Iron Works and in improvement of the property. In 1868 the company began operations and in less than two years completed two of the largest charcoal furnaces in the world, according to Collins, the historian (Ref. 18, vol. 2:168). For at least one year, more than 1,000 men were employed. A town was chartered at the new furnaces called Fitchburg after the two brothers, Frank Fitch and Fred Fitch, who were officers in the company. The product of the two furnaces mentioned above was taken by tramway six miles to Scott's Landing on the Kentucky River near the mouth of Miller's Creek.

In 1871, the Estill Iron Company purchased the Cottage Furnace property (Ref. 18, vol. 2:168).

In those days charcoal was used for fuel in smelting the iron ore. Prof. A. M. Miller states regarding the Fitchburg furnace that wood from 8/10 of an acre of land was required to be made into charcoal for every ton of iron smelted. This caused the forests to be cut away very rapidly.

In Nelson and Bullitt counties concretions of siderite and limonite derived therefrom occur in the Cuyahoga formation of the Waverly age. During the iron mining days in Kentucky furnaces were built to smelt this ore at Bellemont, Bullitt

County, and Nelsonville, Nelson County (Ref. 82:319). Iron ore smelted at the Nelson Furnace, Nelson County, according to Collins (Ref. 18, v. 2), analyzed 29.69 per cent to 35.64 per cent iron. In 1857, Nelson Furnace made 12 tons of pig iron per day.

Water Resources

The water resources of the Knobs include both surface and ground waters.

Surface Waters. The Ohio River forms an important route of transportation, and source of water supply for a number of cities situated along its banks. The velocity of the Ohio River is variable. Between Maysville, near the east end of the Knobs and Louisville on the west, a distance of 198 miles, the Ohio River falls 54 feet, an average fall of 0.27 foot or slightly over three inches to the mile. Floods are common on the Ohio. At Cincinnati the river has passed the danger line (50 foot stage) 23 times in the 46 years previous to 1906. The highest stage during this period was 71.1 feet, which occurred in February 1884; the lowest was less than two feet (Ref. 79:37). The usual range is not much more than 25 feet. The highest floods, caused by the melting snow, usually come in February, or somewhat later. A second rise, caused by rains, takes place in May or June, but is generally less than the one at the close of Winter. A comparatively small rise is produced by Autumn rains. It may come in November, or not until late in December. The lowest stages are reached in August or September, and usually continue into October.

Before the railroads were developed to any extent in Kentucky, the Ohio River played a more important part than it does at the present time, in determining the location of towns and cities, and in the transportation of commodities. Louisville was located at the "Falls of the Ohio." Here goods were carried around the rapids, and due to this geographic control the city of Louisville came into existence.

Steamboat landings occur at Louisville, a portion of which city spreads over upon Knob strata, and at Vanceburg in the eastern Knobs.

A number of cities discharge their sewage into the Ohio River and also use its water for drinking purposes. Careful filtration and chlorination of the water should be practiced before drinking. Lack of these precautions has resulted in typhoid in some cities.

The Kentucky River rises in the mountains of Eastern Kentucky, cuts through the Knobs in Estill County, Plate IV, and flows in a meandering general northwesterly direction to empty into the Ohio River at Carrollton, Carroll County. Between Beattyville, some distance east of the Knobs, and Frankfort, in the Bluegrass, a distance of 189 miles, the river falls 184 feet, or about one foot to the mile The gradient throughout the Bluegrass is low, but increases as the Knobs and Mountains are entered. The stream is subject to changes of volume and velocity similar to the Ohio River; and as the forests are cut off the drainage area of the Kentucky River and no trees planted to take the place of those that have been taken, floods should occur with greater intensity than in the past when the forests prevented the run-off from being too rapid.

Due to a system of dams and locks, the Kentucky River is navigable to slightly beyond Beattyville. Steamboats and barges loaded with coal and other commodities, and rafts of logs towed by steamboats from the timbered regions down stream to the sawmills, may be seen moving along the river; but the railroads have taken a large amount of the traffic that otherwise would have gone by water.

The gateway made by the Kentucky River through the Knobs into the Mountains, has been of great benefit to man in entering the rugged regions of Eastern Kentucky; and along the valleys of this river stretches a railroad line connecting the Mountains with the outside world.

The Dix River rises in the southern Knobs and flows northward into the Kentucky River near High Bridge. A large dam is being constructed in the Bluegrass portion of the Dix River's course. The water will be used for power to operate a large

hydro-electric power plant. The electricity will be distributed over a wide territory.

The Licking, Salt and other rivers have been previously described.

PLATE XXII. INTERIOR OF A CAVE IN MAMMOTH CAVE LIMESTONE.
Big Hill, Madison and Jackson counties. Photo by Augustus Martin.

Dams to impound water for municipal purposes, other than for power, can be constructed readily across the narrow valleys in the rugged portions of the Knobs. A deep and narrow reservoir results in less loss by evaporation than occurs from a shallower but larger water surface. Such a dam was constructed in 1920-1921 across a valley between two high knobs in Pigg Hollow, 3½ miles southeast of Berea. It is 35 feet high and has a reservoir of over 11,000,000 gallons of water. The water comes from springs and streams and is piped to Berea. Ten

springs in the knobs, also supplement the reservoir in furnishing water. This water works system is owned by Berea College.

The gradient of the Knob streams is often steep where they leave the uplands; and their volume fluctuates rapidly and to extremes. Therefore the creeks are not used as a source of power to any extent. Before a water power project is commenced in the larger rivers a thorough investigation should be conducted relative to the numerous conditions necessary to its success.

Ground Water.—Rain and melting snow either flow down the slopes of the Knobs, evaporate or sink into the ground.

Regarding the effects of slopes and porosity of the soils and rocks in the Knobs, the sandy soils and conglomerate and sandstone formations, as well as the rather level tops of the Pottsville which cap certain of the Knobs, cause ready absorption of water. The border portions of these knobs are very steep and allow the water that does not sink in to run off very rapidly. Thus the surface dries quickly. The Mammoth Cave limestone is quite soluble and contains caves, Plate XXII, and underground water. Where there are joint planes or the rock is more soluble, chambers are formed. Underground passages may be formed at several levels one above the other. In exploring a cave a person should be careful not to fall into an enlarged joint plane leading from one passage to another beneath, as such an accident might be fatal. Stalactites and stalagmites occur in these caves. Water seeping along the joint and bedding planes enlarges them and sometimes escapes to the surface along the outcrop of the limestone on the slopes of the knobs. Surface streams usually lower their channels more rapidly than underground streams in the limestone. Thus the underground streams may remain considerably above the level of the nearby surface streams even though no shale occurs in the limestone.

The steep slopes of the Waverly formations cause the surface run-off on these Knob areas to be greater than on some of the other formations, and especially is this true of the Waverly clays and shales, which shed water to a greater extent than the more porous Waverly strata.

Where the Waverly sandstone comes in contact with underlying shale, the water table may cease to sink lower beneath the

surface of the knobs and a stream valley nearby may be deepened lower than this water table. The water comes to the surface as a spring perched on the valley side and is called a "perched" spring (Ref. 79:40). This type of spring may also occur along the larger streams where sand and gravel beds overlie clay, the water coming to the surface at the contract of the pervious and impervious deposits. Soft water is obtained from the springs and shallow wells in the porous Waverly sandstone.

The Ohio shale area is more level than the territory underlain by the Mississippian and Pennsylvanian formations mentioned above. The soil is porous enough to permit water to enter and seep into the Ohio shale beneath it; but on the steep slopes that occur occasionally in this shale area, little water penetrates the strata. The Ohio shale is rather impervious except for the numerous well defined systems of joint planes which occur at nearly right angles to each other. These joint planes permit the water more readily to seep downward into the formation. The water occurs chiefly in the joints, which decrease in size downward. Water from the Ohio shale has been secured from the joints as deep as 50 feet, but most wells are of less depth. They furnish sufficient water for family use. Numerous springs, some highly mineralized, are found along the Ohio shale outcrop. The minerals in the shale produce sulphur, alum, chalybeate and other kinds of water.

The Devonian limestone and the Silurian formations form a border strip of rather flat or rolling land. The limestone soils usually are porous enough to absorb considerable rainwater; but the shale soils are of greater density and do not take in the water so rapidly. On the whole, however, a good deal of water enters the ground due to the rather level topography and porosity of the soil. The Silurian and Devonian limestones yield water for the use of the farm houses. The limestones are magnesian and their water contains magnesium, calcium, and other salts. The shales have joints which admit water. The shale water may contain a high per cent of mineral matter, such as the Epsom salts of Crab Orchard.

In the river valleys water occurs in the alluvium, and wells can secure water from this deposit.

Open wells are liable to become polluted and care should be taken that this does not occur. Cold and clear water may be badly contaminated and be unfit for drinking purposes. Impure water may seep along joint planes or through passages dissolved in limestone and carry typhoid germs from one neighborhood to another.

In the Knobs the soil, if frozen at all, is frozen to such a slight depth and for so short a period that a great deal more of the surface water sinks into the ground during the year than could occur under similar physiographic conditions in a northern climate. The thunder storms of the warmer months often are accompanied by a concentrated downpour. Consequently a smaller quantity of water sinks into the ground and more runs off on the surface. During the Autumn in the Knobs a higher per cent of water sinks into the ground than at more rainy periods of the year because at that time the soil and rocks near the surface contain less water and have more empty pore spaces.

Vegetation plays an important part in preventing surface run-off; but where the slopes have been deforested, or no cover crops have been planted, much water runs off that otherwise would have sunk into the soil. Plowing under a cover crop adds humus to the soil and makes it more porous, thereby permitting more water to sink into the soil. Cultivation also keeps the top soil porous and causes retention of rainwater. Lack of either humus or cultivation leaves the surface hard and compact, and prevents water seeping into the ground.

The lower relative humidity of the drier months produces greater evaporation and aids in increasing the drought conditions of the Autumn months, although the primary cause of the dry season is lack of sufficient rainfall.

Mineral Waters

Mineral water in the popular sense of the term, is spring water containing either an unusual amount of mineral matter, or some unusual mineral. It usually is considered to have medicinal value.

Mineral springs may be classified according to the kind and amount of mineral matter they contain in solution. In the Knobs the mineral springs containing iron compounds are called *chalybeate springs* where the iron is in the form of the hydrous oxide (Ref. 79:86); and *alum springs* when the sulphate of iron is present in appreciable quantities. Ferric hydrate is precipitated from what is known as *red sulphur water*, so named from its color; and black ferrous sulphide is deposited from *black sulphur water*. *White sulphur water* gives a white deposit of sulphur. The iron may be deposited soon after the water is taken from the spring. Hence in order to obtain as much iron as possible, one should drink these waters at the springs.

Hard water is ground water that contains bicarbonate of lime, magnesia, sodium, potassium, together with other bicarbonates and sulphates of magnesium and calcium. Hard waters often become less hard after being boiled for some time. The hardness thus removed is termed *temporary hardness*. The softening of the water is due to the fact that the soluble acid carbonates of lime and magnesium are by boiling decomposed into water, carbon dioxide which escapes as a gas, and the practically insoluble normal carbonates of the calcium and magnesium. The degree of hardness that the water possesses after prolonged boiling is called *permanent hardness*, and is caused by the compounds that are not broken apart by the heat.

The kind of mineral matter in solution is determined by the character of the soil and rock through which the water has circulated. New chemical combinations are sometimes formed from the dissolved mineral matter. The mineral and ordinary pure drinking water obtained from the formations in the Knobs to which the drill is likely to penetrate, commencing with the lowest geological formation, are as follows:

The Calciferous formation at the base of the Ordovician will yield salt water, or salt, sulphur water. Therefore this deep seated stratum should not be sought in hopes of finding water for everyday consumption.

The Silurian shales, especially at Crab Orchard, Lincoln County, furnish mineral waters. The Crab Orchard mineral water obtained its chemical compounds by dissolving the cal-

cium and magnesium sulphates which occur in the Osgood formation, Silurian System, of that locality. These waters also contain other important elements.

Analyses, by Dr. Robert Peter, of water from a Crab Orchard Spring, and of water from the famous Carlsbad, Bohemia health resort, are here given for comparison (Ref. 79:204).

Composition of water from Sowder's Spring, Crab Orchard, Ky., and from the Sprudel Spring, Carlsbad, Bohemia:

(Parts per million.*)

	Sowder's (Peter)	Sprudel (Gottl.)
Silica (SiO_2)	12	144
Iron (Fe)	Trace	1.9
Aluminum (Al)	----------	6.4
Calcium (Ca)	664	110
Magnesium (Mg)	969	16
Sodium (Na)	523	1,874
Potassium (K)	134	23
Bicarbonate radicle (HCO_3)	1,159	1,839
Sulphate radicle (SO_4)	3,666	1,898
Phosphate radicle (PO_4)	----------	23
Chlorine (Cl)	606	724
Bromine (Br)	Trace	----------
	7,153	6,661

*Obtained by computation to ionic form; results originally stated in hypothetical combinations.

One value of the Crab Orchard water is that it contains magnesium sulphate (Epsom salts), which is a cathartic. It is said that physicians have found that this water is not so severe a laxative as magnesium sulphate alone, which is accounted for by the presence of the other chemicals in this water. Salts have been manufactured from the Crab Orchard water and sold as a laxative. Analysis of these salts as given by Dr. Robert Peter (Ref. 79:205), is herewith given:

Composition of Salts from Sowder's Spring, Crab Orchard, Ky.

	Per Cent
Magnesium sulphate	63.19
Sodium sulphate	4.20
Potassium sulphate	1.80
Calcium sulphate	2.54
Sodium chloride	4.77
Calcium, magnesium, and iron carbonates and silica	.89
Bromine	Trace
Waste and loss	22.61
	100.00

The Silurian limestone within a comparatively short distance of the outcrop furnishes drinking water in certain localities. Examples are the Anita and the Royal Magnesium Springs, Oldham County, whose waters are sold for pure drinking water. Analyses of these two spring waters are as follows (Ref. 79:211):

Analyses of Table Waters from the Anita and the Royal Magnesian Springs.*
(Parts per million.)

	Anita (L. D. Kastenbein)	Royal Magnesian (A. M. Peter)
Silica (SiO_2)	16	7.6
Iron (Fe)	.4	.6
Aluminum (Al)	.6	....
Calcium (Ca)	35	48
Magnesium (Mg)	21	28
Strontium (Sr)	....	Trace
Zinc (Zn)	....	.3
Sodium and potassium (Na+K)	2.9	1.4
Lithium (Li)	....	Trace
Carbonate radicle (CO_3)	110	142
Borate radicle (B_4O_7)	....	Trace
Phosphate radicle (PO_4)	Trace	....
Sulphate radicle (SO_4)	Trace	9.4
Chlorine (Cl)	2.8	2.1
Total solids	191	242

*Obtained by computation to ionic form; results originally stated in hypothetical combinations.

The Silurian limestone likewise furnishes good drinking water in other parts of the Knobs.

The Ohio shale contains numerous pyrite and marcasite concretions. Water circulating along the joint and bedding planes may become charged with the iron and sulphur from these concretions, or with alum. The mineral waters thus formed issue in certain places along the bottom of the outcrop of the Ohio shale.

Some of the better known springs flowing from the Ohio shale are: Sulphur Springs, three miles southeast of Lebanon, Marion County; Alum Springs, a few miles west of Junction City, Boyle County; Linietta Springs near Junction City; springs at Mitchellsburg and Shelby City, Boyle County; Hales Well, about 4 miles southeast of Stanford, Lincoln County; Dripping Springs, Garrard County; Estill Springs, just north of Irvine, Estill County; Oil Springs, northeast of Indian Fields, Clark County; Olympian Springs, southeastern Bath County; Fox Springs, 8 miles east of Flemingsburg, Fleming County; Esculapia, Lewis County.

Analyses of the waters at Olympian Springs and Estill Springs are given in the accompanying tables.

Composition of water from salt-sulphur springs at Olympian Springs, Ky., and Aix la Chapelle, Germany (79:206):

(Parts per million.* Analysts: Peter (Olympian Springs) and Liebig (Aix la Chapelle).)

	Olypmpian Springs	Aix la Chapelle
Silica (SiO_2)	23	66
Iron (Fe)	1.2	4.4
Aluminum (Al)	.4	Trace
Barium (Ba)	9	....
Strontium (Sr)	2.6	.1
Calcium (Ca)	89	63
Magnesium (Mg)	42	15
Sodium (Na)	1,934	1,421
Potassium (K)	19	69
Lithium (Li)	.1	0.03
Carbonate radicle (CO_3)	Trace	....

	Olympian Springs	Aix la Chapelle
Bicarbonate radicle (HCO_3)	329	1,023
Sulphate radicle (SO_4)	5.8	276
Chlorine (Cl)	3,081	1,599
Bromine (Br)	13	3.3
Iodine (I)	Trace	Trace
Borate radicle (B_4O_7)	Trace	....
Sulphide radicle (S)	Trace	14
Organic matter	34	75
	5,584	4,628

*Obtained by computation to ionic form; results originally stated in hypothetical combinations.

Composition of Estill Springs Waters* (Part per million.† Analyst, Robert Peter. (Ref. 79:206.)

	Red Sulphur	White Sulphur	Black Sulphur	Chalybeate
Silica (SiO_2)	6.8	4.0	13	32
Iron (Fe)	....	....	48	15
Aluminum (Al)	....	8.5	3.6	....
Calcium (Ca)	81	121	45	148
Magnesium (Mg)	26	25	11	47
Sodium (Na)	99	52	26	7.4
Potassium (K)	42	32	7.6	4.9
Carbonate radicle (CO_3)	197	24	108	72
Sulphate radicle (SO_4)	176	152	67	350
Phosphate radicle (PO_4)	....	Trace	....	....
Chlorine (Cl)	5	5.5	22	5.5
Organic and volatile matter	40	50	59	141
	715	696	410	896
Free carbondioxide (CO_2)	325	360	263	269
Free hydrogen sulphide (H_2S)	4.5	3	35	0

*Geol. Survey Kentucky, 1st ser., vol. 4, p. 143.
†Obtained by computation to ionic form; results originally stated in hypothetical combinations.

Throughout the Ohio shale area of the Knobs, springs and wells in this formation are apt to give alum, sulphur or chaly-

beate waters. For example, wells dug at Berea and Wallacetown, Madison County, to depths generally less than 50 feet often yield sulphur water from the Black shale, and the same is true in other of the Knob counties. The springs and wells of common drinking water have already been described for the various Knob formations under the discussion of Groundwater.

The economic value of mineral springs is considerable. Pure drinking water also is of value and large quantities of ordinary spring water are shipped from the rural districts of Kentucky to the cities for table use. If a citizen in the Knobs has water on his land which he considers salable, it might pay him to have it analyzed, and if it proves of high quality, he should secure a market for it. The cost of transportation from the spring to the market will play an important part in determining whether or not the water can be sold at a profit. It also probably will have to compete with other excellent waters from Kentucky. The marketing of pure drinking water, however, offers possibilities worth considering.

The chemical composition of the water is of economic importance in various industries. Some waters are strongly corrosive. attacking the iron of the steam boiler. Scale deposited by hard waters has numerous detrimentel effects. Soft water is used with better results in making steam than hard water, and soft water also overcomes many of the other disadvantages of hard water. In laundries, soft water is far superior in every way to hard water, both in effecting a saving of soap and in cleansing the clothes. Water used in the manufacture of ice should be pure in every respect. These are only a few of the many instances which might be cited to show the relation of the mineral composition of water to our everyday life.

Salt

Saline springs have been mentioned. Wild animals came to them to lick the salt, hence the name "Licks." In pioneer times salt was obtained from these waters by the early settlers of Kentucky. Concerning one of these licks in the Knob counties, Jedidiah Morse, the geographer, in 1796 said, "Bullitt's Lick at Saltsburg (Bullitt County) although in low order, has sup-

plied this county and Cumberland with salt at 20 shillings per bushel, Virginia currency ($3.33 1/3) and some is exported to the Illinois country. The method of procuring water from the licks is by sinking wells from 30 to 40 feet deep; the water thus obtained is more strongly impregnated with salt than the water from the sea'' (Ref. 18, v. 2:100). The first salt works in Kentucky were erected at Bullitts Old Licks near Shephersville, Bullitt County. About 1830, salt wells were operated three-quarters of a mile from Vanceburg. Salt also was obtained elsewhere in the Knobs.

Since those pioneer times salt wells have been drilled in various parts of Kentucky and the water evaporated to secure the salt.

Native Vegetation

The distribution of the native vegetation is said by some authorities to bear a distinct relation to the underlying formations. Prof. N. S. Shaler (Ref. 107:11) wrote: ''The sugar tree and other maples, and the white oak, are characteristic of the base of the Devonian 'knobstone' series. Beech and red cedar grow on the Sub-carboniferous limestones. Pine, hemlock, laurel, and holly possess the Conglomerate cliffs and peaks. Chestnut and oak forests cover the shales and sandstones of the great plateau bordered by the Conglomerate bluffs.''

On the other hand, Professor H. Garman, Entomologist and Botanist of the Kentucky Agricultural Experiment Station, states: ''The great Kentucky forests present when the State was settled were, it is believed, not due so much to the diversity and richness of our soils as to the central position and diversity of surface and climate'' (Ref. 41:8-10).

In pioneer times the Knob areas contained fine forests. They have, however, been robbed of their timber until at present only remnants of the original growth remain. Today, the natural forest growth on the soils of the Ohio shale consists of several species of oaks, some hickory, chestnut, and Virginia pine. Sycamores closely follow the streams. The Waverly slopes for the most part are covered with small timber and underbrush, the largest trees having been cut. The most valu-

able timber that still exists is white oak, a fine tree formerly common but now mostly destroyed. Hickory, chestnut, pine and hemlock occur (Ref. 5:44). The scrub pine is common and widely distributed in Eastern Kentucky. Redbud and dogwood

PLATE XXIII. A KNOB CABIN.

This log dwelling is situated on a ridge connecting Bear Mountain, Madison County, with a knob to the north. It is 400 feet vertically above the adjacent valleys. The soil in the foreground is derived from Waverly sandstone and shale.

add beauty to the knob slopes in the Spring. The Mammoth Cave limestone soil supports oak, chestnut, hickory, poplar, sugar maple, red cedar, and walnut. The black walnut formerly was more common throughout Eastern Kentucky than now. These trees when of marketable size are valuable, and are being bought up and cut. They are said to be easily grown from the nuts (Ref. 41). The shell bark hickory produces excellent nuts. The Big Shell-bark hickory also occurs and produces larger nuts than the shell-bark hickory. Other hickories grow in the Knobs.

The Pottsville soils on the tops of the higher knobs, have chestnut which is common in sandy soils, oak, hickory, pine and an undergrowth of huckleberry, wild grapevine, sassafras and black-haws. Trailing arbutus, mountain laurel and dogwood also grow here.

Mistletoe, a common parasitic plant, is often seen on the limestone belts of the level Knobs. It is said to be distributed to a great extent by the bluebird which eats the berries in

midwinter (Ref. 41:29). The mucilaginous substance surrounding the seeds no doubt adhers to the bird's beak and is rubbed off on twigs and branches, where on drying it fastens some of the seeds down securely. Mistletoe and holly are picked at Christmas time, and sold in the Knob towns and even shipped outside the State.

The Knob counties are the home of a great variety of all kinds of vegetation. Once, forests covered the region; but today instead of being clothed with majestic trees a large per cent of the Knobs are either under cultivation, or are growing up in scrubby second growth timber and underbrush, or abandoned, are being gullied by surface wash. Only rotting stumps are left to show where the towering trees once stood. In cutting the trees needless waste often has taken place. The ax has been used where the more economical saw should have been employed. Stumps three feet and higher can be seen here and there. Smaller trees have been cut that should have been allowed to grow until they were of greater dimensions. Hardwood trees often are cut for firewood, not only for home use but also to be sold in the nearby towns. This hardwood should have been allowed to grow until it could have been sold for purposes that would have returned the farmer more money than he obtains for it as fuel.

In addition to the farm woodlots, there are some large forest properties. Berea College owns 5,000 acres of Knob land, a large per cent of which is forested. A chief forester lives on this property in an attractive log house centrally located to all parts of the forest. His assistants' houses, Plate XXIII, are located in various parts of the area so that watch can be kept, and a fire stopped before it gathers headway.

While the larger timber from the Knob forests has been cut away, a few logs are still hauled to town in some sections and sold to the local lumber dealers. Many railroad ties are produced, Plate XXIV. Spoke factories use a great deal of the smaller hardwood trees. Thus McCammon & Kellar, Lebanon, make automobile spokes, and wagon hubs and spokes. Oak and hickory trees eight inches up in diameter are used for

spokes, and nine inches up in diameter for hubs. At this same town is a hardwood floor manufacturing company.

Reforestation of large areas of the Knobs should be started. Scientific methods of forestry should be practiced. Trees

PLATE XXIV. RAILROAD TIES BEING TAKEN OUT OF THE KNOBS.
Photograph taken on Narrow Gap Road, Madison County. Knob topography seen to the south.

should be grown for lumber, ties, posts, spokes, hubs and the like. Also hickories, walnuts and other species planted in suitable locations will produce a commercial nut crop which the farmer can gather and sell in the nearby town or city. The forests will aid in stopping soil erosion, preventing floods, the drying up of streams during the dryer months and in other ways be of benefit to man.

Wild Animal Life

Robins, grackles, sparrows, wrens, bluejays, and many other species of birds make their homes for at least a part of the year in the Knobs. The mockingbird and the Kentucky cardinal are especially interesting. Buzzards, which are scavengers, can be seen soaring over the Knob tops. Wild doves are quite frequently seen.

Snakes are numerous in the Knobs. There are the harmless and helpful varieties such as the blacksnake, garter snake, green

snake and others; and also the poisonous rattlesnake and copperhead. The copperhead is said to strike without apparent provocation, but the rattlesnake usually plays fair and gives a danger signal which sounds something like the buzz of a locust. These poisonous snakes enjoy lying on the warm rock ledges of the Mammoth Cave limestone and Pottsville conglomerate. They are the only really dangerous animals that one meets in the Knobs.

Lizzards are seen basking in the sun on a rock or fallen tree. They are all harmless.

Rabbits are very numerous and are generally hunted for food. In the Knobs are also found squirrels, chipmunks, woodchucks, skunks, muskrats, opossums, raccoons, gray and red fox, and wildcats. The furs are brought to town and sold. The fur business, however, is not important.

The Knobs streams contain sunfish, black bass, perch and other varieties of fish. Some of the streams and ponds have been stocked with fish and offer good fishing until the supply becomes exhausted.

CHAPTER V

ECONOMIC CONDITIONS

The Land and Its Uses

Farm land according to the United States census* is divided into unimproved land not in forest, woodland, and improved land.

Unimproved Land

The unimproved land in the Knobs consists of the steeper slopes which are rocky; where the forest has been cut off, the land being left to grow up to underbrush and to be ruined by soil erosion; the more level areas where the soil is too thin or too wet for farm use; and the fields which have been left unprotected by a cover crop and have been gullied by surface water.

The thousands of acres that are in unimproved land due to one or more of the above causes are shown in Table 8. In consulting this Table it should be remembered that the Knob counties also contain Bluegrass or Mountain sections, sometimes both; but due to the irregularities of both sides of the Knob boundary, it is not feasible to make a census for the Knob strata as differentiated from the physiographic divisions in the Knob counties underlain by Bluegrass or Mountain rock formations. In discussing the Knob counties comparison will be made between counties having a more rugged topography and those having a more gentle relief. The differences will be noted that are the result of Knob conditions. In this way the influence of geography upon the life and industry of the people can be determined for the various types of topography.

The total number of acres in woodland or otherwise unimproved land and the percentage of land surface unimproved are given in Table 8.

The influence of topography upon the per cent of unimproved land, including woodland, is shown by the following examples: In 1920, Estill County, which is mostly Knob and Moun-

*Statistical tables, unless otherwise mentioned, are based on figures of the United States Census.

tain territory, had 62.5 per cent of its total land surface unimproved; Lewis, 67.7 per cent; Powell, 72.7 per cent; Rockcastle, 56.2 per cent; Rowan, 76.1 per cent. The Knob counties containing a large percentage of their area in the more level Knob and Bluegrass districts than the counties mentioned above, had the following per cent of their surface in unimproved land, including woodland, in 1920: Boyle, 26.8 per cent; Clark, 23.6 per cent; Fleming, 24.9 per cent; Garrard, 26.4 per cent; Madison, 22.3 per cent; Oldham, 29.7 per cent. The unimproved areas were almost entirely in the Knob and Mountain portions of the counties.

Thus it is shown that the Knob counties containing more level or rolling Knob and Bluegrass land in proportion to their land surface have a lower percentage of unimproved land than is found in the counties having a higher per cent of rough knobs and mountain area.

An increase in the per cent of total land surface unimproved, including woodland, occurred in ten of the Knob counties from 1910 to 1920. The smallest changes in per cent of unimproved land are found in the counties containing the greatest areas of level Knob and Bluegrass land.

Taking the Knob counties as a whole, there was in 1910, 42.3 per cent of the total land surface unimproved, including woodland; in 1920, 44.0 per cent unimproved, as compared to the State's 45.7 per cent. The mountain divisions of Kentucky caused the percentages of the State's unimproved land to be higher than that for the Knobs.

The hilly and mountainous Knob counties have a greater acreage in woodland per square mile of their total area than the more level counties. During the decade of 1910 to 1920, six Knob counties increased their acreage in woodland. This increase per square mile of territory was as follows: Bath County, 10.3 acres; Clark County, 5.4 acres; Fleming County, 0.2 acres; Garrard County, 1.4 acres; Lewis County, 45.2 acres; Marion County, 7.4 acres. The remaining Knob counties lost in their individual acreage in farm woodland. The Knob counties in 1910 had a total acreage in woodland of 854,892 acres; in

1920, 792,741 acres. This was a loss during this decade of 62,151 acres of woodland.

On the individual farms themselves, the more Bluegrass and level Knob territory, the more every acre was improved. For example, Madison County, which has a large percentage of rich, level land, in 1910 had 15.1 per cent, and in 1920, 13.1 per cent of its actual farm land unimproved. On the other hand a rougher county such as Rowan in 1910 had 66.8 per cent, and in 1920, 68.5 per cent of its farm land unimproved. It is a good thing to have a high percentage of unimproved land per farm on the steeper slopes provided the surface is in woods, but in Rowan County from 1910 to 1920 there was a gain in cultivable farm land by the clearing of woodlots of 2,836 acres. During the decade of 1910 to 1920 twelve Knob counties decreased their woodland a total of 91,483 acres. Woodland cannot be decreased continually without finally reaching a point where there are no more woodlots to cut off. The resulting loss by erosion, especially on the deforested bare slopes, is severe.

If the citizens of the Knob counties are to enjoy a lasting prosperity, they should increase the woodlots until all of the steeper slopes are forested. The soil which is now being lost by erosion would then strikingly decrease in amount lost, and the value of these knob lands would increase.

Unimproved land, exclusive of woodland in the Knob counties, includes large areas ruined by overcropping and erosion. Due mostly to the above mentioned causes, there was a total gross loss in the Knob counties of 123,705 acres of cultivable land from 1910 to 1920. This enormous waste of land could to a great extent have been prevented by proper farming methods. The resulting gain to the land owners and the State would have been tremendous.

Timber and Its Uses

In the early days of Kentucky the Knobs were covered with forests of valuable timber consisting of oak, chestnut, hickory, sugar maple, cedar, black walnut, basswood, pine and poplar. Today most of the best timber has been cut and in its place a less valuable second growth of trees and underbrush occupies the

land. Ruthless lumbering operations which considered only the value of the timber then standing and took no thought of reforesting the land as the trees were removed, have been the chief cause for the present lack of lumbering industries on a large scale.

In the districts adjacent to the former iron works in the Knobs large areas were denuded of their forests to supply fuel for the furnaces. In the Red River Iron District, between 1808 and 1875, sections of Powell and Estill counties were completely deforested. Other causes for the decrease of valuable woodland are forest fires; live stock browsing at will, thus injuring the trees and tending to make them decay low down on the trunk; cattle trampling down and eating the seedlings and sprouts; too close grazing and trampling down of the soil, which causes the forest floor to become unfavorable for the retention of moisture and the reproduction of seeds; leaving diseased trees standing when the healthy trees are cut, thereby allowing the diseases to remain in the forests where they spread to other trees. Deforested areas become hardened, gullied, and unfit for the growth of new trees.

The rate at which the forests on the Knob farms are becoming destroyed is shown by the fact that in 1910, 24.7 per cent of the total surface of the Knob counties was in woodland and in 1920, 22.9 per cent. If this loss in the woodlots of the Knob counties continues, the woodland will have entirely vanished by 2047 A. D.

The method of marketing the timber has greatly changed since the earlier days. Formerly great numbers of logs were floated loose or in rafts down the Kentucky and other large rivers. The building of locks in the Kentucky River put a stop to floating out loose logs. Rafts still are towed down stream, however, and at the sawmills along the river far removed from the forests, one can see the log rafts moored to the shore and the logs being pulled out of the water to the mill. Towing the log rafts is more expensive than floating the logs loose, and some of the sawmills which used the loose logs, closed down or moved to other localities.

Portable sawmills follow the retreating stand of valuable timber into the mountains. Railroads bring out the rough lumber and other products of the mills. Disadvantages of floating the logs to sawmills which are overcome by railroad carriage are that the inconveniences incident to getting the logs over the shallower portions of the river channel during the short flood periods are done away with by railroad transportation; when logs were floated out, many logs were stranded or carried past their destination and retrieved, if at all, only after expensive labor; logs became weathered and discolored during their trip down the river; the market was swamped with logs during a short period of the year.

Sawmills and planning mills in the Knob counties in 1920-1921 (Ref. 45), were as follows: Bath, 2; Bullitt, 11; Clark, 6; Estill, 3; Fleming, 4; Garrard, 3; Lewis, 13; Lincoln, 10; Madison, 2; Montgomery, 1; Nelson, 5; Oldham, 1; Rockcastle, 19; Rowan, 9. Thus the Knob counties had a total of 89 sawmills, as compared to 28 sawmills listed for the counties of the Eastern Kentucky Mountains, and 74 in Bluegrass counties. Eight mountain counties without good railroad or water transportation had no stationary sawmills, because transportation by one of these modes of carriage is necessary between the forest and the sawmill and the market for the mill's products. If cheap and satisfactory transportation is possible between the forest and the stationary sawmill, then the logs can be brought to the mill from a long distance even after the forests in the immediate neighborhood are cut away. The life of the sawmill is thereby prolonged.

Comparison of the Bluegrass, Knobs, and Eastern Kentucky Mountains, shows that the sawmills which change the heavy logs into shorter lengths, or rough lumber are moving into the mountain areas following the retreating forests. The rough lumber and semi-finished material thus made is more easily moved and stored than dressed planks, or other finished products such as sash, doors, blinds and the like. The manufacture of these easily injured finished products is carried on near the markets, the rough lumber being shipped to these planing mills from the sawmills nearer the forests. Thus the saw-

mills and the planing mills of the Bluegrass and the border portions of the Knobs are situated where they can secure the rough and semi-finished lumber most readily and cheaply and at the same time be within as easy, inexpensive reach as possible, of large markets for their finished products. The saw-mills of the Knobs are not near large markets for finished products and the forests are retreating away from them, hence they will diminish in number. At present some spoke and hub, and hardwood floor mills are located in and adjacent to the Knobs, using small oak and hickory trees from the Knob slopes in the first named industries.

In order to stimulate the lumber industry as a whole in the Knobs either the population must increase greatly with a resulting demand for wood products from the planing mills; or the Knob slopes must be reforested, thereby supplying the sawmills with a nearby source of timber. Railroads also furnish a market for high grade ties, Plate XXIV, which are getting more scarce in the Knobs. Low grade ties are produced and treated with creosote, but as time goes on even the low grade tie timber will become exhausted unless new trees are planted.

Tan bark is still produced to some extent in the Knobs and adjacent Mountains. It formerly was obtained from the chestnut oak, but now hemlock and chestnut are also used. The production of tanbark in the Knobs as a whole, however, is nearing an end.

Drainage

Drainage of swamp land is not a problem in the Knobs as a whole, because of the rapid fall of the streams from the higher Knob land to the comparatively nearby base level of the Ohio, Licking, Kentucky and Salt Rivers, and their principal tributaries.

Along the river bottoms which are subject to seasonal overflow the water does not drain off readily in all localities with the subsiding of the flood. Such areas need to be drained in order to improve agricultural and health conditions. Lewis County has one operating drainage enterprise under private ownership (Ref. 114:4).

In the vicinity of South Park, Jefferson County, occur areas of very flat land just north and northwest of South Park Hill, as shown in Plate XXV. This region used to be an extensive swamp, but it has mostly been reclaimed by a system of drain-

PLATE XXV. RECLAIMED SWAMP LAND.
Scene near South Park Station, Jefferson County. A good "Piked" road is shown in the foreground. Knobs rise to the southward.

age ditches. General farm crops and vegetables are raised on this land. Tractors can be seen moving over the level surface on the larger farms. Sheep and other live stock are kept in considerable numbers on some of the farms.

The Ohio and other shale belts of the more level Knobs will be especially benefited agriculturally by drainage of the soil. Tile, pole drainage and ditches increase the yield of corn and other crops. Every farmer should drain at least his more level land. He will find it is a good investment. Also subsoiling, lime, phosphate, cowpeas, clover and cultivation will improve the Knob land at almost every point. The steeper slopes on the face of the knob hills drain off more readily than the level land, though even on the knobs occurs land that can be greatly benefited by drainage. The sandy soils of the Pottsville on the crests of some of the knobs, due to their porosity and topographic position, drain quite readily.

Improved Farm Land

Improved Knob county land in farms in 1910 totaled 1,998,435 acres or 57.7 per cent of the total land surface; in 1920,

1,936,881 acres or 56 per cent of the total land surface. The decrease in improved land during this decade was 61,554 acres. In 1920, 54.3 per cent of the total land of the State was improved.

The total net decrease of improved farm land in the Knob counties came as a result of the following factors: a total gain of 91,483 acres of improved land by the clearing of woodlots in the counties of Boyle, Bullitt, Estill, Jefferson, Lincoln, Madison, Montgomery, Nelson, Oldham, Powell, Rockcastle and Rowan. Yet the Knobs as a whole gained only 62,151 acres for the counties of Bath, Clark, Fleming, Garrard, Lewis and Marion had a loss of 29,332 acres of cultivable land due to increase of woodlots. This is a move in the right direction. An increase in woodland could very well occur in all of the Knob counties. A gross loss of 140,106 acres of cultivable land largely due to erosion and other preventable causes occurred in fifteen Knob counties and a gross gain of 16,401 acres other than by clearing in the remaining three counties. This resulted in a gross loss of 123,705 acres of cultivable land for the Knobs as a whole.

A net gain of 28,513 acres of cultivable land is found in Boyle, Bullitt, Garrard, Madison, Montgomery, Nelson, Oldham, and Rockcastle counties. A net loss of 90,067 acres of cultivable land occurred in Bath, Clark, Estill, Fleming, Jefferson, Lewis, Lincoln, Marion, Powell and Rowan. Thus the total net loss of cultivable acreage in the Knobs as a whole equalled 61,554 acres.

The greater the area of level, fertile Knob and Bluegrass land in a county, the higher the per cent of improved land in that county. Counties containing large areas of this level, richer territory had the following per cent of land surface improved in 1920: Boyle, 73.2 per cent; Clark, 76.4 per cent; Fleming, 75.1 per cent; Garrard, 73.6 per cent; Madison, 77.7 per cent; Montgomery, 76.3 per cent; Oldham (Plate XXVI), 70.3 per cent.

The greater the area of hilly and mountainous land in a county the smaller the per cent of improved land as shown by the following: Estill County had 37.5 per cent of its land surface improved; Lewis, 32.3 per cent; Powell, 27.3 per cent; Rockcastle, 43.8 per cent; Rowan, 23.9 per cent.

The total number of farms in the Knob counties increased 16.4 per cent from 1900 to 1910. While the number of farms was increasing, the actual land area in farms decreased 0.79 per cent. Hence the farms were becoming smaller by sub-division.

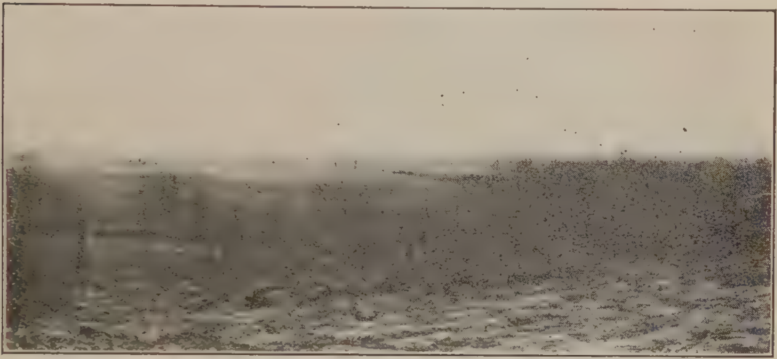

PLATE XXVI. THE KNOB BELT IN OLDHAM COUNTY.
Scene two miles east of Ohio River, about one and one-half miles northeast of Prospect, looking northeast.

From 1910 to 1920 the number of farms increased 1.6 per cent, but the area in farms decreased 2.5 per cent. The total cultivable acreage had a net decrease of 3.08 per cent. Thus the farms were still increasing although much less rapidly than during the preceding decade and were becoming smaller. The falling off in the increase of farms by sub-division indicates that the land obtainable for sub-division into smaller farms was becoming more scarce. Table 10 shows the increase or decrease in farms by Knob counties.

The decrease in the size of farms, Table 11, is shown as follows: In 1910 the average Knob county farm had 85.7 acres (State average, 85.6 acres); 1920, Knob county farm had 82.2 acres (State average, 79.9 acres). But Jefferson County in 1920 had farms averaging 64.2 acres. Intensive cultivation of market crops for the nearby city of Louisville enabled the people to make a living on farms of this size. But from 1910 to 1920 the land in farms in this county decreased 15,329 acres and the number of farms decreased by 267.

The average number of acres of improved land per farm in 1910 in the Knob counties was 57.1 acres and in 1920, 54.5

acres. The per cent of improved land per farm in the Knob counties was 66.3 in 1920. The State average in 1920 was 64.7 per cent of improved land per farm. This shows that the Knob counties taken as a whole have a somewhat higher per cent of acreage per farm under cultivation than the State. This is due to the considerable area of level Knob and Bluegrass territory in the Knob Counties where a far greater proportion of the land in each farm is under cultivation than in the rougher sections, as shown in Table 12.

The topography influences greatly the value of the land. Rugged counties with their poorer soils, difficulties in farming and in reaching a market, have lower land values, other things being equal, than the more level Knob and Bluegrass areas in the Knob counties. The more mountainous counties had the following average land values per acre in 1920: Estill, \$20.80; Lewis, \$18.20; Powell, \$18.30; Rockcastle, \$15.51; Rowan, \$10.10. Compare these land values with those of the more level counties: Boyle, \$121.36; Clark, \$147.82; Garrard, \$121.18; Madison, \$95.09; Montgomery, \$140.26.

The number of tractors used on the farms of the Knob counties is influenced by the topography. In 1920, Clark had 35 tractors credited to it; Madsion, 43; Estill, 1; Lewis, 10; Rockcastle, 8. The average value of Knob county land per acre in 1900 was \$20.37; 1910, \$33.10; 1920, \$67.89. This is a higher land value than in the Knob Belt proper due to the Bluegrass areas included within the Knob counties.

Percentage of increase in land values often bears a direct relation in most of the Knob counties to the increase in the number of farms. Thus Boyle County from 1910 to 1920 had an increase in land valuation of 117 per cent and an increase of 259 farms. Powell from 1900 to 1910 had an increase in land valuation of 207 per cent and an increase of 103 farms. But from 1910 to 1920, Powell had an increase of land valuation of only 15 per cent and a decrease of 154 farms. Similar examples can be seen in Tables 10, 13.

Other factors in addition to the demand for farms influenced land values. In Estill County land values from 1900 to 1910 increased 99 per cent and there was an increase of 216

farms; but in 1910 to 1920, land values increased 92 per cent while there was a decrease of 49 farms, the increase in land values being due not so much to demand for farms for agricultural purposes as to the discoveries of oil that were made during this decade.

The percentage of increase in valuation and the amount of improved land per farm bear a relation to each other. In discussing this subject, land values and the increase in land values are considered for the land without buildings or improvements. Tables 12 and 13 show by counties the number of acres of improved land per farm, per cent of increase in valuation, and actual increase in valuation per acre from 1900 to 1920. These tables show that in the more mountainous Knob counties the per cent of increase in valuation from 1910 to 1920 has been large, but the actual increase in valuation per farm acre has been a fewer number of dollars, and there are a smaller number of improved acres per farm, than in the level Knob counties.

The percentage of increase in land values has been greatest, with few exceptions, where tobacco is grown in quantity, for the value of an acre of land is dependent largely upon the net earnings which can be secured from it. The production cost of White Burley tobacco grown especially in the level Knobs and Bluegrass portions of the counties under discussion, increased 104 per cent from 1913 to 1919. During this time the selling price increased 269 per cent. The higher selling prices of other farm commodities in 1919 as compared to 1909, also helped increase the value of the land. Comparative farm selling prices in 1909 and 1919 for cereals per bushel in Kentucky were as follows: corn, $0.62, $1.55; wheat, $1.11, $2.11; oats, $0.51, $0.91; rye, $0.88; $1.75; barley, $0.76, $1.57.

The average per cent increase in value of Knob county land from 1900 to 1910 was 62 per cent; 1910 to 1920, 105 per cent. The State average per cent increase in value of land from 1900 to 1910 was 64 per cent; 1910 to 1920, 122 per cent.

The reaction from the rapid increase of land values noted above came with the sudden drop in the selling price of farm products. This falling off in the selling price of farm commod-

ities and the general business depression that struck the United States caused a decrease in land values. In the business cycle, it should be remembered, declining commodity prices precede

PLATE XXVII. KNOB STRATA IN ROWAN COUNTY.
Bedford shale, 20 feet thick, overlain by Sunbury shale, 16 feet thick. View looking west along Chesapeake & Ohio Railroad near Rockville, five miles southwest of Morehead. Photo by Chas. Butts.

declining real estate prices. Boyle County's rich land in 1920 sold at a maximum of $350.00 per acre, but by 1921 the depression had begun to be felt on land values and the maximum value was $250.00 per acre. Madison County also has considerable level and rolling land, and its maximum value per acre of $500.00 in 1920 dropped to $250.00 in 1921.

The more mountainous counties which did not raise so much tobacco and other crops that had such a sharp decline in price, did not have their land values decrease as much as the richer, more level areas. Thus Rockcastle County's maximum land value per acre in 1920 was $50.00; 1921, $40.00. Rowan's valuation per acre in 1920 was $25.00; 1921, the same. Powell's land value in 1920 was $70.00 per acre; 1921, $60.00, these values being maximum prices.

The assessed value of all property per farm, Table 14, bears a relation to the size of the improved acreage, to the topography

and fertility of the soils. The improved acreage is greater and the soils richer in the Knob counties containing more level and rolling Knob and Bluegrass land than in the hilly sections. Thus the average assessed value of all the property per farm in

PLATE XXVIII. THE KNOBS OF BOYLE AND MARION COUNTIES.
Scene looking southwest.

Madison County in 1910 was $4,191.00, whereas in Estill County it was $1,389.00; Rockcastle County, $1,134.00; Rowan, $975.00. The increase in the value of farm commodities already described, increased the value of the farms as a whole in all the counties. The average assessed value of all property per farm for the Knob counties as a whole in 1910 was $4,400.00; in 1920, $7,971.00. The State average for comparison with the farm values in the Knob counties in 1910 was $2,986.00; 1920, $5,587.00. The richer, more level portions of the Knob counties caused the Knob average values per farm both in 1910 and 1920, to be higher than the State averages.

The gross crop returns for the Knob counties' farms, Table 14, show that this income bears a relation to the soil fertility, improved acreage per farm and the topography. Counties having the richer, more level farming areas, Plate XXVIII, and the greater number of improved acres per farm had a larger income than those in the more hilly counties where the soil is poorer and the improved acreage per farm is smaller. Thus in 1909 Clark County had an average gross crop return per farm of $993.89 as compared to that of $249.88 for Rowan County. The increase

in the values of various products making up the crops of 1919, raised all of the crop incomes per farm, but the same effect of topography remained in 1919 as described existing in 1909. The decline in the prices of farm products which followed the period of inflation brought the gross crop incomes back toward their 1909 levels. The prices of farm products, however, recovered somewhat from their lowest level recorded during the period of depression.

Considering the Knob counties as a whole, the average gross crop return per farm in 1909 was $606.15; 1919, $1,489.39. The State average gross crop income per farm in 1909 was $536.19 and in 1919 $1,288.32. The average gross crop income of the Knob counties was greater than that for the State both in 1909 and 1919 because of the richer, level and rolling areas of farm land in the Knob counties, a great deal of which is not in the Knob Belt itself.

Crop Production

The principal crop grown in all of the Knob counties is corn. Other cereals raised are oats, wheat, rye, and barley. Tobacco is the important cash crop. Forage crops are grown practically everywhere. Sorghum is planted in many localities. Apples, peaches, pears, plums, cherries, grapes, strawberries, and blackberries are more or less important in various sections. There are some rather large commercial orchards of peaches and other fruits.

Cereals

The Knob counties lie within the great Corn Belt of the United States, and corn is the staple crop of this physiographic division of Kentucky. In 1919 over 76 per cent of the land in the Knob counties devoted to cereals was planted to corn. Of the total cereal production measured in bushels that same year in the Knob counties, 82 per cent was corn.

The climate is the controlling influence that causes the Knobs thus to plant corn as the major crop. A comparison of the Knob climate with that of the greatest corn producing States is as follows: In the celebrated corn regions of this country the

mean summer temperature is from 70 to 80 degrees; the average daily minimum temperature in summer is over 58 degrees; the average frostless season is over 140 days; the annual precipitation is between 25 and 50 inches; the precipitation of July and August totals from 7 to 8 inches. The most critical period as regards precipitation, which is the important climatic factor in determining the yield of corn, is from the middle of July to the middle of August. The most important calendar month, according to J. Warren Smith, is July. The average rainfall for July over the Corn Belt for 28 years was 3.9 inches. He states (Ref. 109A) "If the years of different rainfall amounts are grouped together, it will be found that whenever the rainfall has been one-half inch or more above the normal, the yield of corn has averaged ten bushels to the acre more than when the rainfall has been one-half inch or more below the normal."

The climate of the Knobs falls well within the necessary climatic requirements given above. The mean summer temperature of the Knobs is 74.6 degrees; average daily minimum temperature 62 4 degrees; average frostless season over 152 days and the probable length of the growing season four out of five years, from 165 to 191 days; annual mean precipitation 45.55 inches; rainfall in June 4.26 inches, July 4.66 inches, August 4.05 inches; precipitation for July and August totals 8.71 inches. The July precipitation of 4.66 inches in the Knobs was above the average for the Corn Belt, which was 3.9 inches.

The planting according to E. J. Kinney, Associate Agronomist of the University of Kentucky, extends from the middle of April to the first of June with the greatest acreage planted the first ten days of May. Most of the varieties grown in Kentucky ripen from the middle of September to the first of October. The crop usually is harvested in November and December; while the cutting of corn is generally done the latter part of September.

Therefore poor yields of corn in the Knobs are not due usually to the climate but caused by farm conditions such as infertile, poorly drained soil; lack of cultivation; all of which

detrimental factors often can be remedied by scientific farm practice.

The topography and soils also play an important part in the production of corn. The greatest yields of corn per square mile per county occur in those counties which have the largest areas of the more level surfaced, richer limestone soils, Table 15. In the hilly and mountainous portions corn is grown in the river bottoms and on the hillsides which are not too steep to hold soil sufficient for the growth of this cereal. The use of the steep slopes for a cultivated crop is not a good practice, as it promotes soil erosion; but the small land owner feels that corn is the best, quick crop that he can plant and hence he far too often crops the land until, depleted of plant food and humus, gullied by surface wash, and altogether rendered incapable of producing an adequate return, it is said to be "tired" and is abandoned and allowed to "rest." More woodland is then cleared and the same procedure again takes place. But this method of farming cannot continue indefinitely. There is not enough virgin land.

The average yield of corn in the Knobs proper is about 15 to 25 bushels per acre. Knob soil, however, will produce a good yield of corn with proper care. Robert F. Spence, County Farm Agent for parts of Rockcastle and Madison counties, describes one field which in previous years, at its best, had never exceeded 25 bushels of corn per acre. In 1919 after scientific treatment it yielded 64½ bushels of corn per acre. In 1921 twenty demonstrators in the Knobs, with a total of 480 acres, produced an average of 47 bushels of corn per acre.

Contrast these high yields where proper farm practice is carried on with the average for the Knob counties which in 1919, including Bluegrass areas of these counties, was 26.72 bushels per acre. The average yield of corn for the Corn Belt States as a whole for an extended period of years was 29.7 bushels per acre. The average for Kentucky is 1919 was 22.02 bushels per acre.

In 1909, the Knobs produced 2,451 bushels of corn per square mile of land surface; in 1919, 2,091 bushels. The number of bushels of corn per square mile of improved land in 1909

was 4,242 bushels; in 1919, 3,734 bushels. Statistics of corn production by Knob counties and for the State as a whole are given in Tables 15 and 17.

The reasons that corn is grown so extensively in the more level areas of richer soils of the Knob counties are that the yield per acre is good, being above the average for these counties, and one can farm many acres with machinery. Tractors are coming into use more and more where the topography permits. Corn also is fed to the live stock in the richer farming districts of the lowlands where animal husbandry is carried on more than in the rougher regions.

In the hilly and mountainous sections and on the areas of poorer soils of the Knobs, corn is grown because it requires but few and inexpensive tools to plant, cultivate and harvest this cereal. Corn yields more per acre than the other small grains which might be raised and may be stored readily and fed to the animals on the farm. Corn thus transformed into meat on the hoof is worth more per pound and can be gotten to market more easily than as raw corn, which is the important consideration to the people of the more distant and less accessible Knobs. Much of the corn is ground at the local mill and used for food by the family. Thus corn is an excellent all-around cereal both for the rich, level areas and also for the rougher sections of the Knobs.

Wheat production in the Knob counties is influenced by the physiography. The greatest yields per county occur in the more level areas which as a rule have richer soils than the rougher districts. On these level and rolling lands machinery can be used. In the hilly regions with their poor soils, wheat often has to be harvested by hand and in such localities corn is generally raised in preference to wheat.

This control of the topography over the production of wheat can be seen in Tables 16 and 17, which give the production of wheat for each of the Knob counties. The average yield per acre in the Knob counties in 1909 was 13.23 bushels of wheat; in 1919, 13.94 bushels; for the State in 1909, 12.82 bushels; in 1919, 12.35 bushels.

It is possible with correct farm practice to have a much larger yield of wheat on Knob soil than is usually obtained. In Madison County twenty farm demonstrators in 1919 reported an average of 14.2 bushels of wheat per acre on Knob soil proper. In contrast the average wheat yield on the other farms of the Knob section of this same county was about 7.5 bushels.

Oats in 1919 ranked third among the cereals produced per square mile of total land surface in the Knob counties. Production of oats by counties is shown in Table 17 and from these statistics it is seen that oats are not an important crop in the Knob counties. They are grown chiefly for use on the farm and are placed in the crop rotation. In Rockcastle and southern Madison counties, spring oats are said to "hit" only every two or three years and are not considered in general in these counties as a profitable crop.

Rye, Barley and *Buckwheat* also are produced in the Knob counties. Acreage planted and production of these cereals in the Knob counties and the State as a whole in 1919 are given in Table 17.

Rye is not planted in the mountainous sections of the Knob counties, in general, as much as in the more level, richer areas. Rye is used as a cover crop and plowed under.

Buckwheat was produced in greatest amounts in the Knob counties, in Lincoln County, which adjoins Pulaski County, where in the last several years such large quantities of this cereal have been raised. The best land for buckwheat is a sandy loam. A crop of buckwheat can be grown on the average in 60 days. The soil must not be planted to buckwheat year after year or the fertility will be lost. Buckwheat should be grown in a crop rotation. It is of value in mixtures of crushed grain for cattle as well as food for human beings, while the bloom is good for bees.

The production per square mile of edible beans was 0.758 bushels and dry peas 1.014 bushels for the Knob counties in 1919.

Hay and Forage Crops

Hay and other forage crops covered 33 per cent of the cropped area of the Knob counties in 1919, and yielded a total of 364,212 tons. About 38 per cent of this acreage was timothy, sweet and red clover, alfalfa and other tame or cultivated

PLATE XXIX. ROLLING KNOB TOPOGRAPHY.
Western Oldham County, about two miles east of the Ohio River.

grasses. The remaining 62 per cent stated in the order of acreage consisted of corn cut for forage, small grains for hay, silage crops, kaffir corn and sorghum for silage, annual legumes for hay, wild grasses and root crops. In terms of tonnage, timothy, clover, alfalfa and other tame grasses in 1919 totalled 130,279 tons, or 35 per cent of the hay and forage crop. The remaining 65 per cent consisted of the crops listed above and in the order given for acreage except that silage crops came second and small grasses cut for hay were third in tonnage. The average yield per acre of hay and forage crops for the Knob counties in 1919 was 1.15 tons.

The acreage planted per square mile to tame grasses and the tonnage obtained for each of the Knob counties are given in Table 18. Comparison of the more mountainous Knob counties with those having a more level surface, Plate XXIX, shows that a smaller acreage per square mile was planted to tame grasses in the more mountainous counties than in the more level counties. The Knob counties in 1919 planted 22.7 acres per square mile to tame grasses with a yield of 24.1 tons; State average, 22.8 acres, 23.6 tons.

Sweet clover is the salvation of the thin soils of the Knobs. Wherever sweet clover is grown better crops, better stock, and better looking farms are the result. It also is of great value to the bee industry and for grazing cattle.

There is great value in cowpeas. In 1919, three farm demonstrators under Mr. Robert Spence's direction secured a yield of 1 1/3 tons of cowpeas per acre. Cowpeas grown once every three years for the purpose of being turned under to improve the soil is good farm practice. They also are excellent for hay and forage.

Soy beans as grown in the Knobs by five demonstrators yielded 1½ tons per acre in 1919. Robert F. Spence states that in this test beans in fields inoculated by the soil method were much better and produced from ⅛ to ¼ ton more per acre than fields not inoculated.

A small patch of sorghum is common on the Knob farms, especially in the more isolated portions of the Knobs. The farmer grinds the largest canes for molasses and cuts the smaller canes for feed. Some farmers have two patches of sorghum, generally one acre of sorghum for syrup and from one to five acres for feed. The seed is fed to the poultry, cows and pigs. Rockcastle County in 1919 led in the acreage planted to sorghum with three acres in sorghum per square mile of land area, yielding 10.31 tons and 133.7 gallons of syrup.

The Knob counties planted 0.95 acres to sorghum per square mile of area in 1919, the yield being 2.85 tons and 37.2 gallons of syrup. The State in the same year planted 1.24 acres per square mile of area to sorghum, the yield being 3.85 tons and 50.8 gallons. The acreage and yield per square mile of area is greater for the State as a whole than for the Knob counties. This is because in the Mountain counties where there are few or no railroads, the people must raise practically all of their food. In the Knob counties large areas are level or rolling and railroads are accessible. Manufactured articles are brought in by the store-keeper to take the place of sorghum and commodities which otherwise would have been produced at home. Consequently a smaller acreage is given to sorghum than in the more isolated districts.

Tobacco is the chief cash or money crop of the Knob counties. The climate and soils, especially in the richer, more level parts of the Knobs, as well as the Bluegrass, are suitable for the growing of White Burley tobacco, Plate XXX. Thus Boyle

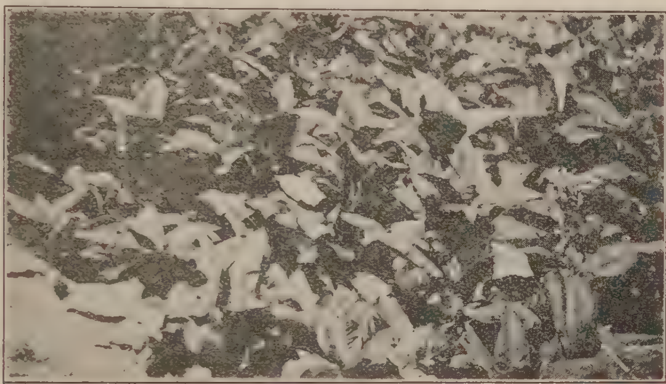

PLATE XXX.
Tobacco is a Cash Crop for the Knob Farmer. Photo by Robt. Spence.

County in 1919 produced 18,926 pounds of tobacco per square miles of area; Clark, 19,330 pounds; Garrard, 46,724 pounds; while Estill County produced 1,058 pounds per square mile; Powell, 831 pounds; Rowan, 929 pounds. Statistics for the other counties, the Knob counties as a whole and the State are given in Table 19.

Tobacco is produced only with much intensive labor. It furnishes quite steady employment throughout the year. If the patch is fairly large and the farmer does not hire outside help, the work is performed by the entire family. Tobacco exhausts the soil rapidly, leaving it in poor condition and unless the soil is cared for properly erosion completes the ruining of the field. Farmers who depend almost entirely upon their tobacco patch for their ready money are unwise as unfavorable climatic conditions may cause a loss after all of their hard work. It is far better to diversify the kind of crops grown.

The decreasing yield of tobacco per acre in 1919 as compared to 1909 is shown by the following, Table 19: Clark County in 1909 produced 1,166 pounds of tobacco per acre, but in 1919 the yield was only 897 pounds. Fleming in 1909 produced

1,024 pounds of tobacco per acre and in 1919, 755 pounds. The yield per acre in the Knob counties in 1909 averaged 997 pounds of tobacco, in 1919, 840 pounds. The State average in 1909 was 848 pounds of tobacco per acre; in 1919, 799 pounds.

Among the important tobacco markets near the Knob Belt are Lexington, Winchester, Richmond.

The price of tobacco has an important influence on the acreage planted and on land values. Burley tobacco rose from a price index number of 100 in 1913 to 369.7 in 1919; and in 1920 the price declined to 105.6. The actual price for White Burley tobacco in 1913 was 12.3 cents per pound; in 1919, 45.48 cents per pound. The cost of production did not increase so rapidly as did the price. The cost of producing a pound of White Burley tobacco in 1913 in the Bluegrass and level Knobs was 12.7 cents per pound, while the cost of production in 1919 was 26 cents. The increase in the selling price was 269 per cent while the increace in production cost was only 104 per cent (Ref. 37:64). When the price fell in 1920, farmers who had greatly over-extended themselves financially were ruined.

Irish Potato Industry

Irish potatoes are raised in especially large quantities in Jefferson County and adjacent parts of Oldham County. In 1919, Jefferson County planted 27.22 acres per square mile of area and produced 2,858.7 bushels. Oldham was second in proproduction of potatoes with 2.53 acres planted per square mile of area and 232.1 bushels produced. The Knobs in 1919 averaged 2.83 acres per square mile of area, yielding 245.3 bushels; State average 1.24 acres, and 77.9 bushels.

The Jefferson County district produces two crops of potatoes per year. The soil in which the potatoes are grown in Jefferson County is a clay loam derived from the underlying limestone. The first crop is raised chiefly east and northeast of St. Matthews. The potato farms average from 50 to 150 acres. Of this acreage about 25 acres are planted to the first crop of potatoes. The first crop, Mr. R. W. Hite, Manager of the St. Matthews Produce Exchange, informed the author, is planted as early in March as possible. March 15 to April 15 is the usual

planting time. This crop matures in commercial quantities around July 4th. The average yield per acre (Ref. 45:181) is from 40 to 50 barrels of 180 pounds per barrel. The principal shipping season for this crop, from the St. Matthews Produce Exchange, extends from about July 4th to September 1st. The potatoes are marketed in Louisville, throughout the Mississippi Valley from the Canadian boundary to the Gulf, and some are shipped to Central and South America.

The second crop of potatoes, states R. W. Hite (Ref. 45:180) "got its name of second crop by reason of the fact that it was in reality a second growth of potato, being produced from seed that was dug early from the first crop and allowed to lie out in the sun for a certain number of days, possibly covered with a little damp straw, and then planted; and if the season happened to be favorable the results were fairly good. But later on after cold storage and ice plants came into general use, the farmer hit on the idea of putting the first crop potatoes in cold storage late in the Fall and carrying them over until the latter part of July. The potatoes then were planted as if they had been grown that season. Now the practice is that the second crop is put in cold storage anywhere between Christmas and the first of March. This produces the seed that grow the first crop as well as the second crop."

"It is a fact that our home grown seed planted alongside of Northern grown seed will give very much better results as a usual thing than the Northern seed. The Northern seed seems to germinate more quickly and grow more rapidly and strongly up to a certain period. But, as soon as the hot, dry weather strikes it, the latter part of May and June, it wilts and perishes and produces a very slim crop, unless the season is very favorable. Whereas our native seed seems to be able to withstand the hot weather, and unless conditions are very unfavorable, will produce a splendid crop."

The second crop potatoes are grown chiefly throughout Jefferson County. The average area in potatoes per farm where grown is about ten acres. More small farm owners raise second crop potatoes, while the first crop potatoes are generally produced by the large growers.

The St. Matthews Produce Exchange stores the second crop of potatoes and gradually sells them during the winter. Individual farmers store potatoes in their own cellars. Considerable amounts of this second crop go south for seed potatoes. Many farmers raise second crop potatoes and sell their crop themselves in the Louisville markets.

"The average shipping production," states Mr. Hite (Ref. 45:181), "is around 1,000 to 1,500 cars of potatoes per year out of Jefferson County and the edge of the adjoining county of Oldham. However, this does not include the home consumption, which is possibly as much or more, as Louisville and vicinity will average 5 to 6 cars of potatoes daily the year round."

The importance of the potato industry in Jefferson County is due to the large market offered by Louisville and the excellent railroad facilities in that city by which the potatoes are economically shipped to distant markets. Were it not for the ready and cheap transportation to market, potatoes, which are bulky and are sold on a narrow margin, could not be produced in the county in such quantities as at present.

The Ohio and Mississippi rivers although important in earlier days for the distribution of potatoes from Jefferson and Oldham counties, are not now used to any extent, the potatoes being shipped almost exclusively by rail.

Marketing of potatoes in this district is also facilitated by two potato produce exchanges or associations at St. Matthews and Buechel, which handle a great deal of the larger growers' products. The St. Matthews Exchange also handles onions, which are raised on the same limestone soil as the potatoes. On these farms also are raised corn, wheat and other grains as well as dairy products. This Exchange has stations at O'Bannon and Worthington which take care of the Oldham County potatoes. The Worthington station is seven miles from a railroad the potatoes being taken by motor trucks from Worthington to St. Matthews or Louisville. O'Bannon and St. Matthews are on the Louisville & Nashville Railroad.

Other sections of the Knob counties and various parts of Kentucky as a whole, may have soil equal or better than that of

Jefferson County for the raising of potatoes but before embarking on this industry to any extent, one should also investigate the marketing possibilities, for upon this part of the business success or failure may depend.

Market Gardening

Truck gardening is most highly developed in Jefferson County because of the nearby Louisville market. The farm products also are shipped to more distant markets over the various transportation lines running out of Louisville. Some produce is shipped by boat from Louisville to local markets along the river.

Jefferson County in 1919 planted 11.651 acres per square mile to vegetables other than sweet and Irish potatoes.

The Knob counties as a whole in 1919 planted 1.025 acres per square mile of land surface to vegetables other than Irish and sweet potatoes, while the State average was only 0.401 acres. The higher average of the Knob counties planted to vegetables is due to Jefferson County being included in the list of Knob counties.

Sweet potatoes and yams were raised in Jefferson County in 1919 in larger quantities than in any of the other Knob counties, the acreage planted being 1.904 acres per square mile and the yield 243.02 bushels. The Knobs in 1919 planted 0.251 acres per square mile of area to sweet potatoes and yams which yielded 27.23 bushels; State averaged 0.370 acres and 30.42 bushels.

Fruits

Fruit raising may be divided into the culture of small fruits and of orchard fruits.

Of the small fruits, strawberries, blackberries and dewberries are raised in largest quantities in Jefferson County, because of the nearby market afforded by Louisville. In 1919 Jefferson County had 0.806 acres per square mile of area and obtained 1475.54 quarts of strawberries. Blackberries and dewberries in Jefferson County in 1919 covered 0.617 acres per square mile of area with a yield of 445.6 quarts.

All of the Knob counties raised these small fruits, and quantities of wild berries were picked on the knob slopes. The Knobs in 1919 had 0.088 acres per square mile in strawberries, and obtained 131.37 quarts; 0.121 acres yielding 93.1 quarts of blackberries and dewberries. The State averaged 0.077 acres and 79.5 quarts of strawberries; 0.06 acres of blackberries and dewberries yielding 44.2 quarts. The Knob counties averaged higher in acreage and production of small fruits than the State, largely due to the production in Jefferson County.

It would be a good thing for the inhabitants of the Knobs if they would raise more small fruits for home use and preserve them so that this article could form a larger part of the diet during periods of the year when fresh fruits are not obtainable. Before embarking on the culture of small fruits on a large scale, one should be sure that sufficient labor can be obtained at picking time; and that transportation to market is such that the fresh fruit can be delivered in good condition, and cheaply enough to ensure the grower an adequate profit. The market also should be large enough to absorb all of the grower's output.

Orchard fruits, Plate XXXI, include apples, peaches, pears, plums and cherries. The climate is suitable, but frosts sometimes occur with damaging effects. The hilly knob land gives good air drainage and protects, in part, the orchards located higher

PLATE XXXI. A KNOB ORCHARD.
Apple and peach trees alternating at Crest View Orchards, Rockcastle County. Photo by Robt. Spence.

up the slopes from killing frosts which cause much damage to orchards in the valleys where the cold air settles. Even the orchard crops on these higher slopes are sometimes ruined by frosts. Heating of the orchards, and other methods of protecting the buds might be practiced more extensively with good results.

Apples produced in Lewis County in 1919 averaged 24.3 bushels to the square mile of area which was the largest yield in the Knob counties.

Several of the more mountainous Knob counties were small producers of apples. More apple trees might well be planted on the knob slopes. The Knobs produced 7.4 bushels of apples per square mile and the State 31.8 bushels in 1919.

Peaches are a rather speculative crop if only a few years time is considered; but one successful crop of peaches about every three years is said by growers to make their average income satisfactory. Conditions are favorable in certain localities of the Knobs to peach growing on a large scale and a farmer with money enough to carry him until he secured a bumper crop might find this business lucrative. Before setting out an orchard, however, care should be taken that the soil is suitable, topography such as to reduce frost action as much as can be expected, transportation facilities adequate and economical and other factors present that will bring success. Thus areas underlain by Mammoth Cave limestone in the Knobs of Rockcastle County within the last few years have been planted to peaches; and in southern Jefferson County the tops of the Knobs and ridges underlain by the Warsaw limestone have a soil in which peach orchards are said to do well. Peaches are grown to quite an extent in the Knob counties bordering the Ohio River. Pears, plums, prunes and cherries are produced in smaller amounts per square mile in the Knobs than in the State.

The Knob counties would be benefited by a greater development of orchard fruits both on a large scale and by planting a few trees of various kinds on the farm for home use. If commercial orchards are contemplated, one should be sure first that he understands the business and that the physical conditions and his finances are of the best.

Grapes are grown in larger quantities in Jefferson and Oldham counties than elsewhere in the Knob Belt, Plate XXXII. The average for the Knobs was 42.3 pounds of grapes harvested per square mile of area; State average, 37.2 pounds.

PLATE XXXII.
Grapes are grown in the Knobs. Photo by Robt. Spence.

Animals and Animal Products

Farm animals of the Knob counties, Table 20, increased from 1910 to 1920 with the exception of horses, asses, burros and sheep, which declined in number during the decade. The greater number of farm animals is beneficial to the land's fertility.

The kind and number of animals kept on the Knob farms are influenced by the geology and topography of the region:

There are more horses in Knob counties which have large areas of level or rolling land than in the Knob counties which have a rougher topography. This is because mules displace horses to a marked extent in the mountainous districts where the mule can do the heavy work which a horse would be unfit to perform. The mule also is considered by many as being surer footed than a horse on the steep, rough knob and mountain slopes. Horses have diminished in numbers in all of the Knob counties except in Rockcastle County where there was a

slight increase. The Knob counties in 1910 had 13.7 horses per square mile; in 1920, 11.2 horses. The decrease in the number of horses was caused by the increase in the number of automobiles, better roads, tractors, and by mules displacing horses.

Mules increased at a greater rate from 1910 to 1920 in the hilly and mountainous Knob counties than in the more level counties. During this decade mules in the Knob counties as a whole increased from 5.1 to 6.6 mules per square mile. The State average increased from 5.6 to 7.2 mules per square mile.

Burros and asses which are negligible in numbers in the Knob counties and State as a whole declined in numbers during the decade of 1910-1920.

Dairy and beef cattle are found in far greater numbers per square mile of area in the counties containing the larger areas of level or rolling Bluegrass and richer Knob land than in the more mountainous districts.

A greater number of beef cattle are fattened on the richer limestone soils of the Bluegrass and level Knob portions of the counties under discussion than in the hilly districts. More dairy cattle are kept in the counties near the larger cities. Thus Madison County in 1920 had 34.7 beef cattle and 18 dairy cattle per square mile of area; Montgomery County 38 beef cattle and 16.1 dairy cattle. Jefferson County which contains Louisville, had only 5.1 beef cattle, and 30.5 dairy cattle per square mile, Oldham County, 16.1 beef cattle and 31.1 dairy cattle.

The number of cattle in the Bluegrass and level portions of the Knob counties decreased from 1910 to 1920, while the number of cattle in the more hilly counties increased. But even then the number of cattle in the more level counties remained greater than in the hilly counties.

The more level counties which had a greater number of cattle also raised more hay and forage per square mile in 1919 than was grown in the more rugged counties as shown in Tables 18 and 20. Clover alone was planted on a greater number of acres in the more level counties having a larger number of cattle than in the hilly counties with their fewer cattle.

Dairy products include milk, cream, butter-fat, butter and cheese. Milk, due to its bulk, weight and perishable qualities, is produced and sold in greatest quantities in districts near to the market where it is to be consumed. These farming districts must have rainfall sufficient to raise the grass and other forage which the cows should consume if they are to give profitable quantities of milk.

The Knobs bear out these geographic and economic principles. Dairy products are produced and sold in greatest amounts in Jefferson and Oldham counties, which are nearest the markets of Louisville and adjacent cities and towns. Jefferson County in 1919 produced per square mile 7319.1 gallons and sold 3653.3 gallons of milk. Oldham in 1919 produced per square mile 7727.4 gallons of milk and sold 2456.5 gallons. Oldham, therefore, led in milk production but came second to Jefferson in gallons of milk sold.

The more level Knob counties in general, sold more milk per square mile of area than the hilly counties. The Knobs have a greater number of gallons of milk produced and sold per square mile than the State average because Oldham and Jefferson counties are such large dairy districts.

Cream, butter and cheese are products of a higher value per pound than whole milk and hence can be shipped economically a greater distance than the whole milk. Although cream can be produced economically in regions more distant from market than is possible for whole milk production, counties near the large market of Louisville led in the sale of cream.

Creamery companies have local agents in the various towns throughout the Knobs, as well as other parts of Kentucky, who buy the cream brought to them by the farmer and ship this cream to the large stations of the companies. Thus a farmer can dispose of the cream very readily, especially if the cream is sweet, clean and of a general high grade. The cash received for the cream gives the farmer money during periods of the year when he may particularly need it. The dairy cattle also help keep up the fertility of the soil. Jerseys and other dairy cattle which give a high butter fat content in the milk are best in regions remote from a market for whole milk.

More butter was sold in Jefferson County in 1919 than in any of the other Knob counties, the amount being 537.9 pounds of butter per square mile of area. The more hilly counties sold the smallest amounts of butter. Powell County sold 48.3 pounds of butter per square mile; Rowan 42.1 pounds. Knob counties situated a long distance from the larger cities could produce and sell butter to the cities in far greater amounts than they do. As it is, the sale of butter is increasing in certain of the Knob counties. Rockcastle increased her sale of butter from 38.1 pounds per square mile in 1909 to 82.1 pounds in 1919. Estill County increased the amount of butter sold from 55.6 pounds per square mile in 1909 to 69.5 pounds in 1919. In the Knob counties as a whole, however, as well as the State, there was a decline in the amount of butter sold from 1909 to 1919.

Jefferson County ranked first in the production of cheese, with 42.6 pounds of cheese per square mile in 1909 and 5.93 pounds in 1919. Garrard County increased her cheese production from 0.08 pounds per square mile in 1909 until in 1919 she ranked second among the Knob counties with 2.36 pounds per square mile. The Knob counties as a whole and the State declined in cheese production during the decade of 1909 to 1919. The location of cheese factories in the Knob counties distant from the city markets should prove beneficial to the farmer.

An increase in dairying should be of economic importance to the Knobs. The food for the dairy cattle is raised on the farm, much of the plant foods goes back again into the soil in the form of manure, and the milk, cream, butter and cheese are sold. Dairy cattle and pasturage go together. Silos will aid the milk production. Barns should be kept clean. Solid and liquid manure should be carefully saved and placed on soil. The land will then produce better crops, and the dairy products will give a nice cash return for the labor and money invested.

The sheep industry, Tables 20 and 21, is often associated with hilly land that is not readily cultivated. Certain areas in the Knobs are especially suitable for the raising of sheep and

this industry should be developed. But the fact is that more sheep are kept on the richer, level portions of the Knob counties than in the hilly districts. Clark County, in 1919, 1920, ranked first in the number of sheep and pounds of wool produced per square mile, having 69.5 sheep and 253.9 pounds of wool. Oldham County came second with 52.6 sheep and 223.7 pounds of wool per square mile. The rough surfaced Knob counties had the fewest sheep and pounds of wool produced per square mile of area. For example Estill County had 4.6 sheep kept per square mile of area and 15.2 pounds of wool produced.

In the Knob counties as a whole the number of sheep per square mile decreased during 1910 to 1920 from 44.8 to 20.0 sheep; while the State average declined from 33.9 sheep per square mile to 17.6 sheep. Dogs are said to be one of the chief drawbacks to the successful development of the sheep industry.

Goats are insignificant in number in the Knob counties. But milk goats could be kept profitably in the Knobs and this industry should be developed.

Swine are raised and fattened in far greater numbers in the level Knob counties than in the more hilly counties. On the average the counties containing the largest number of swine also produce heavy yields of corn per square mile, as shown in Tables 15 and 20.

The raising and fattening of hogs is increasing in the Knob counties. Care should be taken to inoculate the swine for hog cholera, otherwise serious losses may be incurred.

Poultry and eggs are products that can be made to pay well on the Knob farms. This industry can be carried on upon land that is too steep and poor for the usual branches of agriculture to prove very successful. The poultry houses should be firmly built and adequately ventilated without drafts. They should be light, clean, dry and rat proof. The poultry house should face the south so that the cleansing, health giving rays of the sun can penetrate every part of the house. The poultry should be fed only the best grades of grain, bran, middlings, corn meal, grit, oyster shells and pure fresh water. Patent chicken feeds that are guaranteed to produce wonderful re-

sults should be regarded with suspicion. Thus poultry should be cared for in a careful, scientific manner.

Eggs and poultry are of high value per pound and since farmers can bring these products in over the country roads to points of shipment, these commodities can be sent to distant markets. The Knob farmers sell their eggs and poultry to stores in the nearby towns, and to commission merchants who ship to the larger cities of Kentucky and also to cities outside of Kentucky such as Cincinnati, Pittsburg, and even New York City. One commission merchant whom the author interviewed had specially prepared metal boxes in which he mailed fresh eggs by parcel post to private retail customers in New York City. The higher price obtained far more than offset the expense of shipping the few dozen eggs the box contained to such a distant market.

A large poultry and egg company, the S. H. Grinstead Co., Inc., is located at Lebanon. This concern has branch houses in various parts of the southern Knobs and adjacent territory which gather in the poultry and eggs from their own local districts and ship to the main plant at Lebanon. The farthest of these shipments is from Columbia, Adair County, about forty miles from Lebanon. Transportation is by motor truck.

On arriving at the Lebanon plant, the chickens are fattened on a carefully prepared mixture of pure food. The fattening process is successful if the poultry have not been kept cooped up three days or more. If they have been confined for that length of time, their vitality on the average is said to have gone out of them and they will not generally fatten enough to make them a good paying proposition. Hence the packing house where the poultry are fed and dressed must be near the farming sections from which the chickens come. The feeding makes a superior quality of meat on the bird. The chickens are graded, weighed and packed one dozen to the box. The packed product is kept in cold storage, Plate XXXIII, until shipped in a refrigerator car almost exclusively to New York City.

Eggs are graded and candled. Dirty eggs are broken, the white and yolks are separated. The whites and yolks are each sold in thirty pound cans. Clean eggs are shipped to New York.

The egg shells are used for lime on the fields near Lebanon, as is the poultry manure from the plant. The feathers are sold to a pillow factory. The Grinstead Company have their own refrigerator plant. The entire feeding and packing house presents

PLATE XXXIII.

Cold Storage Room of the S. H. Grinstead Company's Poultry Packing Plant, Lebanon, Marion County.

a fine example of clean, orderly, practical efficiency from the moment the poultry and eggs are delivered until they have left on a refrigerator car for New York, via the Louisville & Nashville Railroad.

The Knobs should increase the poultry in all areas. Rockcastle County, for example, already is increasing her poultry. In 1910 this county had 195.2 head of poultry per square mile of area and in 1920, 300.3 head.

Egg production was greatest per square mile of area in Garrard County which ranked first among the Knob counties both in 1909 and 1919, with 2083.8 and 2018 dozen eggs respectively in these years. The more level Knob counties have more poultry per square mile than do the hilly counties, as shown in Table 22, which gives poultry and egg statistics for each of the Knob counties.

Bees are suitable to Knob topography and honey is a product of high value per pound that can be brought to market over

rough roads and shipped profitably for long distances. To aid the bees in their work, sweet clover should be planted. The clover will help the bees and at the same time bring fertility to the soil.

The rougher surfaced Knob counties rank high in the number of hives of bees and the production of honey per square mile of area. Estill County in 1910 had 3.1 hives per square mile and in 1909 produced 30.1 pounds of honey; in 1920 and 1919 this county ranked first among the Knob counties with 5.5 hives per square mile and 50.6 pounds of honey. Lewis County ranked second and Powell County third. In general the hilly and mountainous Knob counties have increased their honey production greatly since 1909. This is a step in the right direction. The more level Knob and Bluegrass counties which stand high in other kinds of farm products produce only small amounts of honey. For instance Boyle County in 1920 had 3.2 hives per square mile and in 1919 produced 10.4 pounds of honey; Clark County 2.2 hives and 6.6 pounds of honey. The Knobs in 1910 and 1920 averaged 3.1 hives for each year per square mile with 22.7 pounds of honey in 1909 and 24.3 pounds in 1919; State average 3.8 hives in 1910, and 3.9 hives in 1920, producing 38.7 pounds and 39.9 pounds of honey.

CHAPTER VI

PREHISTORIC PEOPLE OF THE KNOBS

In the remote past Kentucky was inhabited by a people who made and used stone spear heads, axes, knives, arrowheads and other implements of war and peace. Because of this extensive use of stone in their everyday life, these people are said to have lived in the Stone Age.

The Stone Age had two distinct divisions: (1) the Paleolithic, or "ancient stone," era, when the fragment of rock or material was brought to the desired shape by comparatively rough chipping; (2) the Neolithic, or "recent stone" era, when much finer chipping was performed, together with rubbing or grinding of the stone implement which gave it a polished surface. Cruder fashioned stones, however, were also made during the Neolithic era.

These people, long since extinct, built numerous mounds for burial, religious, and other purposes, and hence have been called Mound Builders. Their handiwork, such as carvings and etchings on bone, pottery, pipes, and many other articles, found in England, France, Kentucky, Ohio and other regions show that they possessed skill far higher than that of the early stages of savagery. Their engineering works in Kentucky exhibit an insight into military tactics that makes one proud that they were Kentuckians.

The original home of the Mound Builders is unknown. Various theories have been advanced, however, and Gerard Fowke, Archaeologist, in his work for the Ohio Archaeological and Historical Society, gives the following conclusions (Ref. 38): "The western coast of North America may have been accessible to primitive Asian peoples by way of Behring Strait; along ocean currents; or by means of islands in the Pacific, now submerged.

"Under present conditions of climate no extensive travel is practicable across the Strait except for the Eskimo; though small parties from farther south may sometimes use this route.

"The Japan current makes it possible, now, for any race of Southeastern Asia, including the Malays, to reach the Alaskan coast.

"The hypothesis of former islands in the equatorial portion of the Pacific, in a position to afford any assistance to a movement in this direction, involves geological changes within recent times, of which we have no evidence. It also involves a reversal of winds and ocean currents whose trend is now away from the American coast instead of toward it.

"It seems probable that the center of distribution for the first Americans was that part of the Pacific Coast containing the Gulf of Georgia and the mouth of the Columbia River. From here they spread southward along the coast and eastward over the Rocky Mountains.

"This dispersion dates from so far in the past that different tribes of Indians now vary as greatly from each other in psychological attributes as do different nations of Asia or Europe.

"When one part of the American race started eastward and the other southward from their pristine home, the separation was final. There is no good reason for believing a general migration ever took place in either direction across the territory intervening between those who reached the Ohio Valley and those who established themselves in New Mexico and southward; though traders and roving bands probably created and maintained a communication along this line."

The Mound Builders generally chose their village sites where there was water for drinking and other purposes, and where there were streams that yielded fish. They were also inclined to settle near fertile bottom land which produced food more readily than the rougher areas. Wild animals came to the springs and creeks to drink: and the Mound Builder, lying in wait with his bow and flint-tipped arrow, killed, and skinned them with his stone knife, scraping the skins with a piece of sharp edged flint called a Scraper.

The mounds he built are located in the valleys. They were used for burial, religious, military and other purposes. Burials were also made in stone-walled graves; in rock houses

situated in the knob sandstone cliffs; and in excavations dug in the earth of the valley. Caves were occasionally used for this purpose. With the dead were buried implements of everyday peaceful pursuits, and weapons employed in the hunt and in war. Copper and clay beads, pottery, mica, and other articles were laid beside the deceased tribesman. Numerous flint arrow heads, stone axe heads, scrapers, stone knives and many other relics have been unearthed in the Knob fields by the plow, or have been found near the surface. Excavations in the dirt floors of caves, as well as in the mounds and other forms of graves, have revealed the bones and utensils of these people.

The forts of the prehistoric people of the Kentucky Knobs are so situated as to secure the natural protection of the cliffs and passes. Many of the works of the Mound Builders remained until Kentucky began to be settled, when numbers of the mounds were destroyed by cultivation of the land and through other causes. Quite a few of these mounds that have become obliterated in more recent times, were visited and described by Professor C S. Rafinesque, a brilliant man who was appointed a professor in Transylvania University in 1817.

Space will not permit of a detailed description of the various remains of the Mound Builders found in the Knobs. For an extended account of this subject see "The Prehistoric Men of Kentucky," by Col. Bennett H. Young. This volume is a Filson Club publication.

In Nelson County Col. Young has described some interesting ruins accredited to an unknown people, which are located four miles from Bardstown on land owned by Mr. Jerry Hagan. This relic of the past is a stone structure consisting of two parallel walls. He believes it was originally "a stone residence for a large number of people, and across the walls had been placed timbers. The roof had been covered with cane or reeds, probably plastered over with clay, and the space within had been used as a dwelling by the early inhabitants of Kentucky. The location strategically viewed from a military standpoint, could have had no particular value." The date of the building of this structure is not known.

A remarkable evidence of the engineering and military skill of the prehistoric inhabitants of Kentucky is found in a fortified mountain top known as the "Indian Fort," which is situated three and one-half miles southeast of Berea, Madison County, on the Narrow Gap road. Up to 1922 the only investigations made of this fort, as far as the author is aware, were as follows: A Mr. Wm. H. Robe, now deceased, of Berea, who was interested in archaeology, had gathered relics from the fields, but did not publish an account of his finds, as far as is known. A part of the Indian Fort knob is still called Robe's Mountain, after this gentleman. A sketch map of a small part of the mountain was drawn by another man many years ago, but this map is of no scientific value as regards the fortifications. In 1910 Col. Bennett Young's "Prehistoric Men of Kentucky" was published. In it he described his reconnaissance survey of the Indian Fort. He also made a sketch map showing the walls that he found. Col. Young appears to be the first white man to realize the extent of the fortified area.

But no detailed map of this Fort had ever been made, nor had any extended, scientific exploration ever been carried on, nor burial places found, up to the time that the author in 1922 and 1923, surveyed and investigated the Indian Fort, Plate XXXIV. In the exploration of the Fort the author was assisted by Mrs. Mavis Reynolds Burroughs, and by Professor Samuel Mayfield. Mrs. Burroughs and students from the Department of Geology of Berea College helped during the instrumental survey of the Fort. These college men also did good work in excavating the rock houses. All assistance was rendered gratis.

Dense underbrush covering much of the area, which presents a very rough topography, made the work naturally difficult. The investigations brought to light portions of the Fort never before outlined by a white man and resulted in the discovery of many new archaeological features.

This fortification of the prehistoric people of Kentucky is located excellently from a military viewpoint with reference to the surrounding country. It commands the trails, now roads, leading to Big Hill, an entrance to the mountains of Eastern

Kentucky; at the base of the fort on the south is Narrow Gap through which a road passes connecting the Mountains and Knobs with the Bluegrass; Boone's Gap and the trails running through it are within easy striking distance by the warriors of the Fort; the Bluegrass with its fertile lands and streams lies to the north and northwest. This stronghold could have served both as a place of refuge for the inhabitants of the plains in time of war, and as a citadel from which warriors could have sallied out and levied tribute upon all those who came and went through the mountain passes.

The Fort embraces the entire top of a knob about 200 acres in area which connects with other knobs on the west, east, and north, by narrow, steep sided ridges. The valleys at the base of Indian Fort Mountain are chiefly in the Ohio black shale from which the slopes of Waverly strata rise rapidly upward forming the lower portions of the knob. Near the top the Mammoth Cave and Gasper limestone capped by Pottsville conglomerate, Plate XXXV, rise in places vertically to a maximum of 200 feet. In some areas the conglomerate has become broken by weathering, and under the influence of gravity has separated along its joint planes into huge blocks which have slumped down the slope making an irregular edge to the crest of the knob. From the base to the top of Indian Fort Mountain there is an

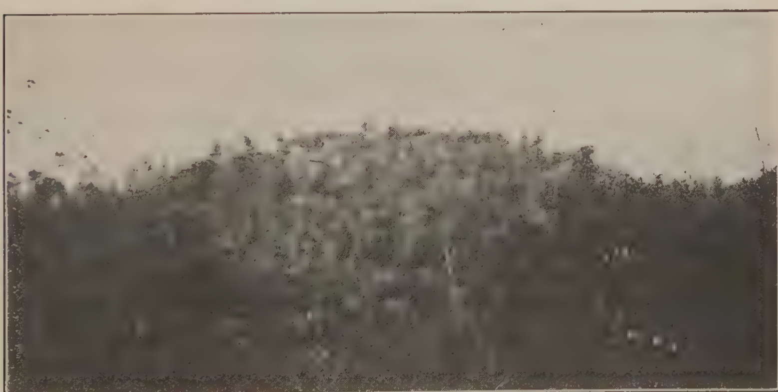

PLATE XXXV. WEST END OF INDIAN FORT MOUNTAIN.

Cliffs of Mammoth Cave limestone capped by Pottsville conglomerate. The remnant of a low stone barricade extends along the top of the precipice for 1,200 feet. View taken looking northwest.

ascent along a trail, of 520 feet vertically within an average horizontal distance of less than one-half mile. In some places, off the trails leading to the top, the rise is nearly perpendicular.

In the limestone the author's party discovered and explored a cave of moderate size. Evidences of the existence of other caves, the entrances to which were partially blocked by falling rock were also found. Prior to this time no caves had been reported in the limestone of the Fort. On cold, damp days moist, warm air issuing from crevices and other openings in the conglomerate roof of caves in the underlying limestone gives the appearance of streamers of smoke on the top of the knob. This air feels warm compared to the outer atmosphere

In the Pottsville conglomerate cliffs occur numerous rock houses. Beneath the present sandy floors of several of these rock houses there were discovered the burial places where the prehistoric people had laid away their dead, doubtless several thousand years ago.

The top of the Indian Fort Mountain can be reached by five narrow trails, three of which lead from adjacent knobs; one winds up a long ridge from Narrow Gap, the last follows a creek which is cutting into the knob, the final ascent being up the steep slope at the head of this branch. The summit can be gained in possibly five other spots, all of which follow the ravines. The slopes in all cases are very steep. Elsewhere the Fort is guarded by perpendicular cliffs 50 to 200 feet high.

The land surface on the top of the Fort is flat or gently rolling. Pottsville conglomerate and sandstone underlie the scanty, sandy soil; and here and there the bedrock outcrops. A second growth of trees covers the Waverly slopes and the crest of the knob, except where the vegetation has been cleared away on the more gentle slopes for farming purposes, or where the bare rock is at the surface. Only a few moderately large trees remain, and large stumps are rare. On the conglomerate soil wild grapevines, and briars add to the denseness of much of the underbrush. In the northern part of the Fort is a spring used at present by animals. Wildcats, foxes and smaller creatures live among the fastnesses of this jungle of underbrush, making

their homes in caves and under the ledges of precipices. Copperheads and rattlesnakes are seen.

At every point where the top of the Fort might possible be gained, this prehistoric people had erected rough stone walls or barracades behind which they placed piles of small and large stones for "ammunition."

To the west of the Fort are two other knobs. The more westerly is known as West Pinnacle and towers over the rolling Knobs and Bluegrass regions below. Doubtless upon this pinnacle sentries were posted, as limestone "ammunition" was found within small rock houses in the conglomerate. The central knob is called the Dome. It connects with the Indian Fort by a ridge about 50 feet wide. The trail along this ridge extends to the base of the conglomerate which rises 35 to 50 feet above the path, effectively guarding the entrance to the Fort. The path, about four feet wide, here winds along the base of the cliff for approximately 55 feet with the conglomerate cliff rising on the right and an extremely steep slope falling away on the left. The trail then enters a joint plane whose width varies from four to nine feet in the conglomerate up which it climbs at an angle of 36 degrees to the top of the mountain.

The defenders of the Fort built a wall, No. 1, across this joint plane, blocking the path, 53 feet slope-distance from where the path enters at the lowest point of the crevice. The wall is high up in the conglomerate and yet the rocks of which it is composed are limestone as well as conglomerate, showing that the prehistoric people carried the limestone to its present position from the Gasper and Mammoth Cave limestones which underlie the conglomerate. This wall is now mostly demolished, Plate XXXVI. It is in places two to three feet high, but dirt has filled in behind the wall on the upslope side to such an extent that the wall is not at first apparent.

Above this cross-wall the conglomerate cliff rises 20 feet vertically to a flat topped promontory from which the conglomerate again rises 15 feet vertically to the crest of the knob. Opposite the right-hand end of the cross-wall as one ascends the trail is a recess in the conglomerate large enough to accommodate a few warriors. This crevice in the side of the large

joint plane afforded a complete shelter from arrows and stones of an attacking party; and at the same time allowed the defenders to shoot from cover, brain their adversaries with stone axes, and thrust them through with spears as they endeavored to climb the wall.

PLATE XXXVI. THE WEST GATEWAY TO THE INDIAN FORT.

Looking eastward up the narrow joint plane in the Pottsville conglomerate, the remnant of a stone barricade can be seen extending across the path to the left of the cap. To the right of the barricade, a recess in the conglomerate afforded protection for the defenders and at the same time allowed them to attack the enemy who attempted to scale the wall without themselves being seen.

The military skill of the prehistoric people in locating the wall is obvious. The attackers had to cross a narrow ridge, exposed to the missiles of the defenders; then enter a very narrow chasm, climb 53 feet up a steep and slippery slope; and at last, doubtless more or less out of breath, climb a perpendicular wall, during all of the time being subjected to a hail of rocks, arrows, and at the wall by axes and spears in the hands of a concealed enemy.

South 80 feet from the west entrance a wall (No. 2 on the map) composed of loosely piled rocks laid a few feet back from the edge of the conglomerate cliff runs for approximately 1200 feet along the south side of the Fort with occasional breaks where the precipice is very high or the wall has been washed away. This wall tops a conglomerate cliff in places only about 20 feet high, while at others the cliff is too high to be scaled even with ladders if a few resolute people manned the top. At the head of the hollow in which is wall No. 5, wall No. 2 acts

as a secondary line of defense re-enforcing wall No. 5. The author is of the opinion that wall No. 2 served as a protection against the arrows of the enemy stationed below the cliff who otherwise could have cleared the top of the cliff's edge with their arrows, and under cover of this fire have scaled the precipice. The stones composing this wall are not washed down to their present position, except in individual instances, as is seen from the fact that where the cliff is too high for an attacking force to climb, the wall does not occur even when the slope of the surface behind the cliff's edge on the top of the Fort is the same as on the parts of the Fort where this wall No. 2 is found.

Enlarged joint planes in the conglomerate occur at points No. 3 and 4 shown on the map. They traverse the face of the cliff and afford a means of ascent to the crest. Joint plane wall No. 3 is three feet wide. A wall four feet high was built, and still stands, across the entrance to this crack in the rock. Joint plane, wall No. 4, is 9½ feet wide. A wall now 2 feet 9 inches high was built 10 feet slope-distance up the crevice from its lower opening. The stones on both of these walls are flat limestone and conglomerate rocks, laid regularly upon each other, forming a solid obstruction. Behind wall No. 4, the joint plane continues with its floor slanting upward for 35 feet slope-distance when the top of the cliff is reached. Above both of these walls the conglomerate cliff rises nine to twelve feet vertically. On the top of the conglomerate overlooking the walls in the joint planes beneath, are piles of rocks ranging from small stones that could be thrown easily for a considerable distance, to large rocks that could be very effectively dropped upon the heads of an attacking party. The wall in the larger of these two crevices was built 10 feet back from the entrance to the joint plane so that the enemy could be caught by a fire from three sides as they rushed to the assault. They could be slaughtered by the defenders of the Fort stationed above and possibly also behind the wall before they could climb over or pull down the barricade.

Wall No. 5 is 652 feet long. It guards the head of a ravine whose stream has made an entrance through the cliffs

and worn an accessible passageway to the crest of the knob. This wall extends crescent-shape along the face of the eroded conglomerate slope from the base of the conglomerate cliff on the right as one goes up the slope, to the conglomerate cliff on the left. In front of the wall, the slope as a whole slants away at an angle of 20 degrees for a distance of about 1,000 feet slope-distance, when a terrace in the Waverly formation is reached on the east side of the valley. On this terrace at the foot of the slope an attacking party came into range of arrows and stones discharged from the cliffs on either side of the hollow. In climbing the 1,000 feet of slope the attacking force continually came into a more severe shower of missiles until at last, out of breath, they reached the wall.

Here at the wall the invaders found new obstacles. Near the east end of the wall, right hand as one goes up the slope, the wall strikes up the knob 75 feet slope-distance to a narrow terrace in the conglomerate when the wall turns to the right for 37 feet along this terrace and originally joined the bottom of a conglomerate cliff which rises about 30 feet above the wall. A re-entrant angle is formed in the wall at this end of the rampart. Before the wall on the narrow terrace is a drop of 14 feet in the conglomerate. The position at the extreme east end of the wall was further strengthened by constructing the wall along the terrace with regularly laid stones so that the rampart stands perpendicular as shown in the accompanying photograph, Plate XXXVII. The perpendicular wall is now 37 feet long by 2½ to 3 feet high. Flat blocks of limestone and conglomerate were used, their dimensions varying from six inches to three feet long by six to fifteen inches wide by three to seven inches thick. Some had been cut into rough rectangular shape. Smaller stones were used to level the surface upon which the perpendicular wall was laid. The crevices between the larger rocks of the wall were filled with small stones wedged in tightly, thereby making the wall more firm. An "ammunition" pile of rocks was heaped ten feet behind the regularly laid wall.

Westward to the left as one ascends the slope, from this regularly built wall, the main wall composed of a mass of lime-

stone and conglomerate fragments piled loosely together, slants diagonally down the ravine for 75 feet slope-distance as already described, and then turns and extends across the head of the valley for 540 feet, being made up of loose rocks of limestone

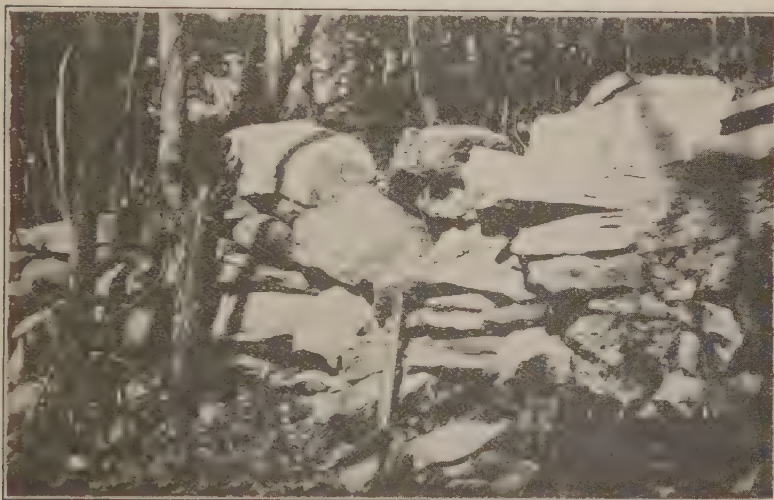

PLATE XXXVII. REGULARLY LAID WALL AT THE INDIAN FORT.
This wall, now three feet high, was constructed by the prehistoric inhabitants of Kentucky at the entrance to the fort from Chestnut Hollow. The wall is made of Pottsville conglomerate and Mammoth Cave limestone and rests upon a bedrock of conglomerate.

and conglomerate except in three places where the wall is regularly laid. These perpendicular walls occur at two points near the middle of the main wall for distances of about ten and fifteen feet respectively, being separated by a loosely laid wall. Also at the west end of wall No. 5 the main wall strikes up the slope diagonally and originally tied on to the bottom of a fifteen-foot cliff of conglomerate rock formation which forms the top rim of the knob. At present for the last fifteen feet the wall is almost gone, but starting fifteen feet from the cliff the wall is laid regularly for 23 feet and is still three feet high. The construction is similar to that already described at the east end of the main wall.

Behind wall No. 5, 30 feet vertically up the slope, the second low, loosely made wall, No. 2, previously described, acts as a second line of defense.

At the east of the main wall, No. 5, where the regularly built wall meets the loose wall, another wall, No. 6, extends 225 feet slope-distance up the slope and across the narrow ridge of the knob to the high cliffs on the north side. Only a few of the bottom stones of this wall are left, but it apparently acted as a defense in case the east end of the main wall were turned by the attacking force. It certainly is not a white man's wall for it was laid down the rough, partly bare conglomerate slope to exactly the point where the regularly laid wall meets the loose wall which slants down the ravine as already described. There could not have been any reason for building such a wall to keep cattle in a field, as a fence would have been built across the top of the slope at the edge of the knob and would not have been extended down a rather steep slope of almost entirely solid rock to a terrace only a few feet wide. This wall, however, is situated favorably for defensive purposes and was constructed by the prehistoric people for that end.

Wall No. 7 composed of loose rocks runs along the edge of the knob for 380 feet of solid barricade and 28 feet at the end of scattered rock. At present it is eight to ten feet high above the land surface directly behind it within the southeast end of the Fort and three to four feet high elsewhere. In front the knob drops away in a precipice 30 to 40 feet high in the conglomerate or forms in places a very steep slope to a rather narrow terrace, below which a cliff, 70 to 100 feet high in the limestone, gives an additional defence. An attacking force would have had first to gain the terrace, where it exists, and then have scaled the conglomerate at the top of which is wall No. 7. Behind this wall at irregular intervals, depending upon the chances of attack, are "ammunition" piles of rocks. The path leading up to the Fort from Narrow Gap, and the trail from East Pinnacle both are guarded by this wall.

Below the east end of wall No. 7 occurs a terrace between the lower portion of the top cliff of conglomerate and the top of the limestone precipice. The more gentle slope of this terrace is reached by a trail from East Pinnacle. From the north end of this terrace an attacking party can outflank wall No. 7 and reach the crest through joint planes and broken Potts-

ville cliffs, for no wall can be found protecting this approach. Apparently the defenders relied upon rocks and arrows fired from the Fort to destroy the enemy while they were on the open terrace, for doubtless this slope beneath the Fort, as well as all of the other approaches, was deforested, probably by fire. At present there are few large stumps or trees anywhere on this knob, although, of course, fires and the decay of the stumps would have obliterated their existence even if they had covered the slopes since the time of the prehistoric defenders.

A joint plane at No. 8 is blocked at the top by a huge, flat fragment of conglomerate. It would be impossible to gain the crest of the knob through the joint plane, if even a few of the defenders manned the top of the cliff.

Walls No. 9 protect the head of a hollow which faces the northwest. Here the summit can be gained, for the limestone and conglomerate cliffs have been broken by erosion and are weathered into steep but accessible slopes over a short horizontal distance. Above the terrace formed, rises a perpendicular cliff of conglomerate about 15 to 20 feet high, but this could be scaled for in places it is somewhat broken. The walls have been partially destroyed. The main wall probably once extended from the top end of the solid limestone precipice diagonally back to a huge boulder of the Pottsville conglomerate. From the side of the boulder toward the Fort, this wall can still be easily seen running back on a slant for about 80 feet to the conglomerate cliff that rims the Fort. To the left, as one looks down the hollow, other walls to a total of about 142 feet connected fallen boulders until the accessible slope was guarded. A few feet of these walls are still made of regularly laid rocks, but the greater portion of the entire defense at No. 9 is made up of loosely piled rocks.

Wall No. 10, consisting of 110 feet of solid stone breastwork one to three feet high, and 93 feet of scattered rock, guards a narrow valley whose sides are composed of cliffs and their talus slopes, until the wall is reached. Behind the wall, upstream, the cliffs are weathered, broken, and accessible. On the east side of the ravine the wall originally joined the top of the limestone cliff, but at present for a few feet this part is miss-

ing. On the west bank, the wall runs diagonally up the slope to the proper strategic point of union with the crest of the limestone cliff. The angle of slope of the land surface in front and behind the wall averages 21 to 26 degrees. This wall has been destroyed in places by erosion, but in other sections its loosely piled rocks are so large that they have withstood the action of the surface wash and gravity. The rampart could be carried only after great loss of life, as an attacking force would have to climb the steep ravine all the distance from its mouth within range of arrows and stones from the cliffs that border the gorge. They would then have had to climb a steep slope and storm the stone rampart. If successful, they would have had to make their way up the talus slope, on the summit of which are conglomerate cliffs about fifteen feet vertically above the top of the weathered slope. This conglomerate formation is broken and accessible if carried by overpowering numbers in the storming party, but it is doubtful whether any except a very few could ever have reached the crest in the face of the great boulders that would have been rolled down upon them.

Wall No. 11, 150 feet long, was built at the top of a steep ravine. It connects the top of a conglomerate cliff which was here broken by the erosive action of the headwaters of the stream. The stones are loosely laid, and only a remnant of this wall exists at the present time.

Walls Nos. 12 and 13 protect the north end of the Fort where a trail leads along the ridge from the next knob to the north. This path passes beneath a promontory of conglomerate rock which rises a total of about 30 feet vertically above the trail which is here eight feet wide. On the other side of the trail the land slopes steeply for a short distance and then falls away in a precipice formed from the Mammoth Cave limestone. To prevent an attacking force from entering the Fort between the conglomerate promontory above the path and the cliff, a wall No. 12, was built away from the conglomerate down the slope toward the precipice for a distance of 50 feet, to a conglomerate boulder 20 feet wide. Most of this wall is still visible. From the boulder which is only about 30 feet from the

edge of the limestone precipice, the wall extends for 50 feet to another boulder, 20 feet wide, and then 30 feet to a portion of the top of the conglomerate cliff which outcrops along that side of the Fort.

To the right of the trail going southward toward the Fort, the conglomerate promontory just described above, has a heavy wall, No. 13, of loosely piled limestone and conglomerate rocks on its crest, affording a protection to the defenders of this advanced post overlooking the path. South 130 feet from this north apex of the Fort, a cross wall, No. 15, was laid from the top of the high conglomerate cliff on the west, 53 feet to the present path and then on to the point on the top of the conglomerate cliff 15 to 20 feet high, where the end of wall No. 12, previously described, was tied. This cross wall was higher up the slope on the east side of the path than the wall that started at the conglomerate promontory, and served as a second line of defense. All of these walls at the north end of the Fort are loosely piled, and only the bottom parts of the walls remain except at the apex where the pile of rocks is three to four feet high above the bedrock on which they have been heaped.

From the north apex of the Fort a thin, loosely laid wall extends southward along the top of the conglomerate cliff 170 feet; then for 100 feet it runs between a number of large conglomerate boulders on top of the cliff, which is broken into irregular jagged masses of rock. When a point 350 feet south of the north apex of the Fort is reached, a wall, No. 14, occurs jutting straight down the steep hillside from the broken conglomerate edge to a conglomerate boulder 20 feet wide. This wall is made up of loosely heaped rocks. It is 36 feet long, 27 feet wide and 9 to 10 feet high, measured perpendicularly to the surface of the ground upon which it rests. From the boulder to which this wall is connected, on the downslope end, another wall was laid 50 feet to another boulder. The ascent in front of these walls, though steep, is readily made by an agile climber for the solid rocks have been weathered into a talus slope breaking the precipices in the conglomerate and limestone at this point. South of the apex 570 feet on the west side of the Fort the limestone cliff again becomes so steep and high

as to be impregnable if defended by even a small force. In front of wall No. 16 the cliff is broken and the Fort, were it not for the wall, would be accessible up a talus slope.

The spring, S, furnishes a meagre supply of water to the headwaters of the brook which develops into a ravine guarded by wall No. 10. Along the headwaters of this creek, just south of the spring, the banks are low and there is some gently sloping land on either side of the channel which is covered with water by a slight rise in the stream in time of heavy rainfall. A dam constructed across the brook at this point would have held back water running from the spring and formed a reservoir large enough to supply water for drinking purposes for the defenders of the Fort and their families and animals.

The above descriptions are of walls and other features of the Fort which were unquestionably constructed by these people. There is another wall, No. X, 174 feet long, and one-half to one foot high, made of regularly laid flat rocks which faces east in the central part of the Fort, 16 feet back from the edge of the top cliff of conglomerate. Below this rock formation comes a talus slope ending in a high limestone cliff. As far as can be ascertained nowadays, there should have been no danger of an enemy gaining the top from this part of the mountain, and therefore, if this wall is the work of the prehistoric defenders, why did they place it here? It may, however, be a wall constructed by some pioneer settler who lived on the knob so long ago that all recollection of him has been lost to the farmers now inhabiting the region. Such a pioneer might have built this wall to hold the soil in place, but an argument against this view is that the soil has not been banked up on the upslope side behind this wall and it seems strange that an early settler with all of the land at his disposal, would have gone to the labor of constructing this wall. A point in favor of this wall having been made by the prehistoric defenders is that its south end commences a few feet back from where the large conglomerate rock lies above the top of the joint plane at No. 8. This gives the appearance of there being some relation between the wall and the protected joint plane. The fact that the wall is regularly laid would seem to show that the defenders of

the Fort considered this point especially liable to attack, for the other walls that are regularly laid are at the ends of loosely piled rock walls where an attacking force would attempt to turn their flank. Whether or not this wall at No. X is of prehistoric origin cannot be said definitely.

For 325 feet scattered sandstone and a few limestone rocks occur at No. Y. From a knoll overlooking the headwaters of the creek it runs past the spring on the down slope side and disappears in the level ground to the east of the creek. These rocks are not entirely derived from the underlying bedrock, for they contain limestone fragments together with pieces of sandstone different from that of the bedrock beneath. Is it a demolished wall that once acted as a secondary line of defense before the spring was reached, or is it ammunition strewn over the ground? It cannot accurately be determined.

In the cultivated field just north of the spring, hundreds of pieces of limestone and conglomerate, the size of "missiles" found in "ammunition" piles, are scattered throughout the field. These rocks must have been brought to the field for the bed-rock is of sandstone high above the conglomerate and limestone. Stone axes, both polished and roughly chipped, and arrow heads are scattered about. It appears as though a battle had been fought at this place.

On the knob to the north of the Fort, limestone fragments were found as though some one in advancing toward the Fort had dropped his missiles; but this knob is too accessible and evidently no resistance of any importance was offered on its slopes.

The only signs of habitation that had been discovered on the Indian Fort up to the time of these investigations were flint arrow heads, a few stone ax heads, and a multitude of flint chips left by the makers of arrows and other stone articles. These flint chips are especially plentiful on the higher points of the Fort. Many of the chips and arrow heads probably were left by the American Indians, but others were made during the Stone Age.

A prehistoric grave was discovered, November 11, 1922, by the author and his party, in a small rock house, No. R, 55 feet

west of the end of wall No. 5. A trail leads from the wall to this rock house. Below the path, which is five to six feet wide, is a cliff about fifteen feet perpendicularly. The mouth of the rock house is 16 feet wide, 5 feet high and 11 feet deep to an opening in the back formed by a joint plane, 2 feet 8 inches wide by 1 foot 10 inches high. Across the main entrance limestone and conglomerate rocks had been piled to block the opening. When discovered this wall was only one foot high and extended out from each side of the entrance leaving a clear space of five feet near the center. The floor is of sand from the weathered conglomerate of which the roof, walls and bottom are composed. Flat limestone and conglomerate rocks averaging one to two feet by one foot by two inches thick covered the floor. A hollow sound was made when the floor was struck with a pick.

A trench was dug from the entrance along the center of the rock house floor. The heavy limestone and conglomerate rocks, and the sand were removed. The flat rocks and a yellow, sandy clay extended ten inches beneath the surface. The limestone rocks had been carried up to the rock house from the limestone outcrop further down the side of the knob and therefore were placed in their present position by human hands.

At a depth of ten inches beneath the surface several pieces of Muscovite mica, one inch by three inches, were uncovered; at this same depth a flint arrow head of a dark gray color, a flint knife of the same material as the arrow head; a flint scraper; what appeared once to have been a very crude spear head and a small ax head of stone; and a splinter of bone about one and three-quarter inches long but too weather and small to determine whether it was from a human being or an animal. The warrior had been buried with all of his accountrements. This fact indicates that these people believed in a future life.

Below the horizon in which the implements occurred came a soft grayish dust intermingled with sand, for nine inches in depth, when a reddish clay began and extended to the rock floor of the rock house. Roots of vegetation growing just outside the rockhouse had sought the gray dust layer in preference to the soils above and below, apparently deriving more nour-

ishment from it than from the other material in the rock house. This gray dust may have been derived from the deer skins and other material in which these prehistoric people sometimes wrapped their dead.

Surface water running down the joint plane in the back of the rock house seeped through the grave during the centuries and dissolved away the skeleton of the prehistoric warrior.

A second trench was dug three to four feet to the right of the first excavation as one faced the interior of the rock house. It revealed several small pieces of charcoal, a scraper of flint, an ax head made from the Pottsville conglomerate, and a splinter of bone about one and one-half inches long.

These prehistoric people had done their best to guard the dead and to preserve their bodies, for in addition to the wall at the front of the rock house, the joint plane in the back is still partially sealed by a regularly laid wall of limestone and conglomerate rocks with small stones filling the crevices in exactly the same manner as already described as occurring in the regularly laid walls of the Fort. Evidently the people, or their relatives, who made this prehistoric grave also constructed the walls of the Fort.

A rock house near No. 8, Plate XXXIV, on the east side of the Fort, was explored. Beneath four feet of loosely piled rocks which had become a compact mass, were found several scrapers and pieces of charcoal. Between the lower part of the rock pile and the back of the rock house several flat rocks three feet by two feet were found standing on edge. Directly behind these rocks a gray dust similar to that previously mentioned, again was discovered. It would appear that these flat rocks had been placed in front of the grave and the heap of rocks placed before the perpendicular slabs of stone. The large rock pile completely sealed up the entrance to the sepulchre. But water, during the ages, had dissolved away all trace of the body or bodies that had been placed in the tomb. The charcoal found in this rock house and in several others in the Fort are the remains of ceremonial fires that formed part of the burial service.

In another rock house were discovered several small pieces of broken pottery. The material used in this pottery came from the New Providence green shale formation; and scattered through the shale body of the pottery are crinoid "buttons" which came from limestone occurring in the knobs.

The people who inhabited the Fort, it seems reasonable to suppose, lived at least during inclement weather, in the caves that occur in the limestone upon which the conglomerate rests. The holes up which the warmer air now rises forming a fog on cold days, ages ago may have been large enough to serve within the walls of the Fort as entrances to these caverns. The entrance to one of the caves, No. C., in the limestone was covered with icicles when discovered, but on breaking the ice down a narrow passageway led to a comparatively warm, dry interior.

Numerous rock houses of various sizes occur in the conglomerate and the exploring party found scrapers and flint chips in the sandy floors. These recesses were used by the prehistoric inhabitants as protection from the weather, but they would have been cold compared to the real caves in the limestone. Doubtless walls were built across part of the opening of the lower entrances of the rock houses which would then have served nicely as a retreat from the days and nights of late Fall and Winter.

Further exploration of the Indian Fort will undoubtedly uncover many valuable and interesting records of the past.

One of the several prehistoric mounds in the vicinity of Berea, Madison County, was investigated by Prof. W. G. Burroughs during May, 1924. Students from the Geology classes of Berea College aided in the excavation. This mound is on the farm of J. D. Clarkston, about two and one-half miles northeast from Berea. It is on the crest of a knob of Ohio shale adjacent to the Dixie Highway.

The mound is roughly circular, approximately 36 feet in diameter. A section of the mound was as follows:

Loose fragments of limestone and Ohio shale upon the surface.

Yellowish clay	10-16 inches
Charcoal containing a mass of bones at top of mound	7- 8 inches
Yellow clay	10 inches
Flat sandstone rocks	7-12 inches
Yellow clay containing copper "breast plates" and human skull fragments	10-12 inches
Layer yellow sandstone	3- 4 inches
Charcoal mixed with yellow clay	8 inches
Clay overlying bed rock of Ohio shale.	

Thus a fire had first been kindled upon the surface of the knob. Clay had been placed over the charcoal. Flat rocks had then been laid upon the clay. The dead chieftain wrapped in some fibrous material was laid upon clay placed on the rocks. All that remains of the wrapping is one-quarter of an inch of carbonaceous material resembling bark which was found between the copper plates and the sandstone rock upon which the body rested. The jaws and teeth of the chieftain are quite well preserved. The cusps of the teeth have been worn flat by chewing hard food. The warrior was evidently advanced in years. Other portions of the skull also still remain. With the chieftain were four pieces of copper armor, worn for protection or as ornaments. Three are flat, smooth copper plates 1/50 to 1/60 inch thick. In size they are: 7.5 inches by 4.3 inches; 8 inches by 4.4 inches; 8 inches by 4.8 inches. They all are curved at both ends. Each has two holes through which thongs passed fastening the breast plate to the chieftain's tunic; or they may have been suspended from thongs. Near the lower edge of one plate is a jagged hole. A fourth piece of copper in shape somewhat resembling a canoe, is 7.4 inches long by 2.5 inches wide by 1/60 inch thick. Clay and a layer of rocks covered the body. This top rock layer is dome shaped and curves downward on all sides to meet the bottom rocklayer at the perifery, the horizontal diameter being about seven feet. Clay covers the top rocks. A sacrifice was next burned upon the top of the mound and the entire mound covered with clay upon which was placed a layer of rocks brought from the valley to the north and west.

A prehistoric fort which white men have never before known existed, was discovered by the author, W. G. Burroughs, November 9, 1925. This fort is situated three and one-half miles

east of Berea and one-half mile northeast of the north end of the fort on Indian Fort Mountain. The newly discovered fort includes the entire top of a large knob which is entirely separate from other knobs except for a narrow ridge at the base of the cliffs of the fort on the west end. The lower portion of the

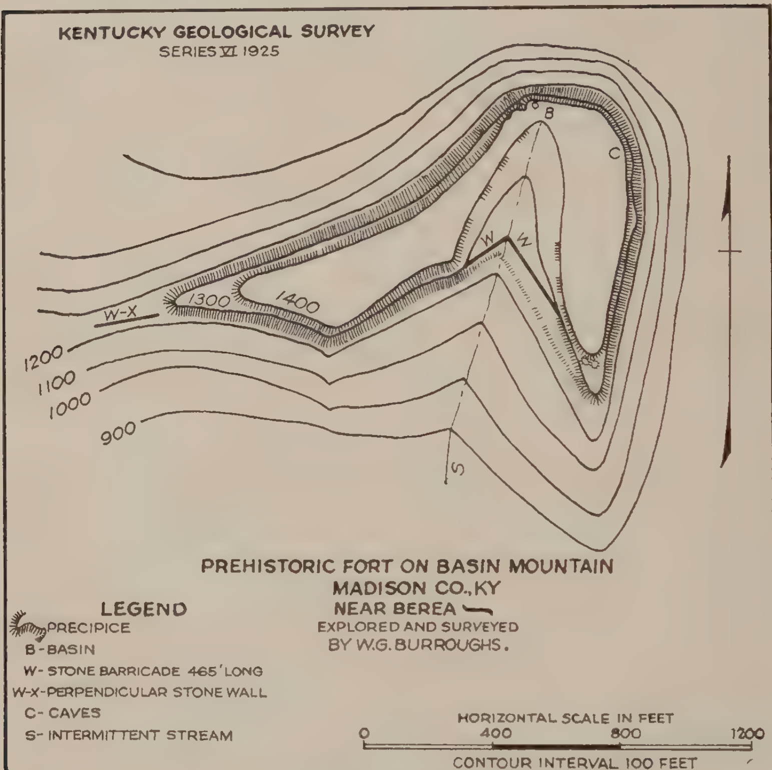

PLATE XXXVII-A.

Map of Prehistoric stronghold on "Basin Mountain." This prehistoric fort was discovered, explored and surveyed by the author, W. G. Burroughs.

knob consists of a steep shale and talus slope which rises 400 feet vertically above the valleys. Above this slope cliffs of Mammoth Cave and Gasper limestone, except at one point, completely surround the upper parts of the knob.

The limestone is broken in a few places by joint planes two to four feet wide up whose extremely steep floors an agile climber can reach the top of the cliff. But access to the terrace

above would be impossible along these crevices if they were defended by people armed with stones and primitive weapons stationed along the upper edges of the cliffs. Two of these joint planes occur at the west extremity of the knob where the cliff is 50 feet high. The east end also has a similar crevice. Along the north side the limestone has been worn away for a few yards but all of these points can be defended easily.

A narrow terrace occurs at the east and west ends of the knob and here and there along the other sides. Above this terrace rises a cliff of Pottsville conglomerate in places forty feet high. It is broken occasionally by joint planes but could not be readily surmounted if determined people manned the summit. At certain points the conglomerate and limestone cliffs unite and fall 200 feet straight down where the talus does not rise so high along the base of the limestone. On the south side, as shown in the accompanying map, a stream has worn away the cliffs and formed the only comparatively easy path into the fort.

Here the prehistoric people built a stone barricade 465 feet long which extends from the top of the limestone across the break in the cliff to the upper edge of the limestone on the opposite side of the ravine. At present this rampart is in places five feet two inches vertically from top to bottom on the front side and at this point seven feet across. The entire barricade is in the form of a V with the apex upstream. The defenders could thus hurl their missiles upon an attacking foe from three sides. This line of defense differs somewhat in shape from barricades on Indian Fort Mountain which cross a ravine in the form of a curve when the valley is wide enough to permit this form. The top of "Basin Mountain" fort is rolling land and covers about eighteen acres.

A few inches back from the edge of the conglomerate on the north central part of the fort is a roughly rectangular basin which has been hollowed out of the conglomerate. The rock here is in no respect different from other areas of its exposed surface. The dimensions of this basin are 8 feet by 5 feet 8 inches by 5 inches deep. The long axis runs about northwest-southeast. It contains water. A theory for the origin of this basin which the author suggests is that since there is no spring

within the walls of the fort, as far as at present known, the prehistoric people who held the fort may have drawn water up the side of the cliff and emptied it into the basin which they had hollowed in the rock. Skins could have been used to hold the water and grapevines or other material been used for rope.

On another promontory to the east is a much smaller depression in the conglomerate which appears to have been just started when work was abandoned. This second basin is also rectangular and located near the edge of the precipice. These points are the best places on the fort for water to be lifted up the cliff to the summit and poured into these basins. Also being exposed to the sky they easily catch rain water. Because of these basins this knob will be called "Basin Mountain."

Along the east and northeast sides of the fort where the conglomerate comes in contact with the underlying limestone, many of the joint planes have been enlarged by solution into long, narrow caves. Fifteen to twenty feet from the entrances to these caves they usually become larger where the limestone floors have been dissolved away. In several caves are pits about 150 feet deep in the limestone. In two caves thus far explored are many charred branches and sticks. Some of these pieces of charcoal are far back in the caves in places where they could not possibly have been washed by water. It is doubtful whether any of the charred branches could have been washed to their present positions for many conglomerate boulders which have fallen from the roofs block the bottoms of the passages and have to be climbed over in penetrating the caves.

It would appear as though these pieces of charcoal had been taken into the caves by the prehistoric inhabitants while the charcoal was hot. The warm charcoal would have given heat to those crouching over it without making smoke. The ventilation is good and the temperature comfortable in these caves without heat, even when snow is falling outside in the open air, but the charcoal would have given added heat. It would seem improbable that white hunters would have carried all this charcoal down the face of a 20 to 30 foot cliff and then on into these caves. Therefore it was without doubt carried into the caves by the prehistoric inhabitants.

One cave has a large oval shaped mound of earth near the entrance. A large rock was evidently placed in such a position as to block the floor of the cave so that the earth could not be washed out. In this mound are scattered patches of the whitish

PLATE XXXVII-B. "BASIN MOUNTAIN," A PREHISTORIC STRONGHOLD.

The entire area bordered by the top of the gray limestone cliffs is within the fort. Where the cliffs are broken as shown at right center of the photograph the entrance is defended by a stone barricade 465 feet long. View looking north..

substance previously described as occurring in graves in the Indian Fort. Pieces of charcoal are mixed through the earth of the mound. It is evidently a place of burial.

At the west end of the knob a perpendicular stone wall about 220 feet long and 2 to 4 feet high extends out from near the south side of the joint-plane in the limestone cliff, see Plate XXXVIIA, and continues along the narrow ridge of land that stretches from the fort to a knob to the west. The wall is just to the south of the top of the ridge. Its origin is unknown. It is not a fence made by white men for it does not extend the entire length of the ridge and could not keep cattle confined to any spot on the slopes. It is probably part of the defences of "Basin Mountain."

One theory which the writer advances is that "Basin Mountain" was held by people who were besieging Indian Fort Mountain to the south. This smaller fort on "Basin Mountain" would then have been of importance as it would have made it

dangerous for the defenders of the Indian Fort to have sallied out into the Bluegrass. The perpendicular wall which is on the side of the ridge facing Indian Fort would have prevented the people on Indian Fort from crossing the ridge in going northward, and in isolating "Basin Mountain" from the chain of knobs to the west.

The fact that the long, stone barricade across the ravine of "Basin Mountain," is of a different shape than ramparts across similar ravines in the large fort also seems to indicate that the people on the two forts were of different tribes. On Indian Fort Mountain, even the small joint planes a few feet wide have stone walls built across their lower portions. On "Basin Mountain," no walls were built across joint planes as far as can be discerned. In order to obtain water for a body of men of sufficient numbers to man the walls and joint planes on "Basin Mountain," access to the streams of the valleys was necessary. This would imply that the people who held "Basin Mountain" were in force strong enough to command the streams of the lowlands. The walls of "Basin Mountain's" fortifications appear to have been more hastily made than those on the Indian Fort.

The people who held "Basin Mountain" evidently expected an attack, but either felt that their numbers and position were strong enough to repel attack, or they did not have time to throw up more finished works. The defenders of Indian Fort Mountain were in fear of attack for even the smallest detail was thought of and no chances were taken. The north end of Indian Fort which is nearly opposite the fort on "Basin Mountain," has a complicated system of ramparts. Further explorations may reveal new facts about these forts and their people.

CHAPTER VII

EARLY SETTLEMENT AND DEVELOPMENT

After the disappearance of the Mound Builders, Indian tribes inhabited Kentucky. They made numerous trails, some of which later became the white man's roads. Buffalo, also, made traces in search of salt springs and pasturage.

The main Indian trails of Eastern Kentucky connected with an important warpath that ran north and south in the Appalachian Valley. Less important trails connected with these major trails. One of these principal trails in Kentucky was the "Warrior's Path," or the Cumberland Gap Trail, which extended "from Red River across the Kentucky at the mouth of Cow Run (near Irvine, Estill County), up Station Creek, across the Cumberland-Kentucky watershed to the Cumberland River at Buffalo Creek and Flat Lick, and thence up the river and its branches to Cumberland Gap" (Ref. 117:64, 65, 69). A branch of the "Warrior's Path" is given on some maps as leaving the main trail near the head of Station Camp Creek, running due north, crossing the Kentucky River above the main trail near the mouth of Miller's Creek, passing across the headwaters of the Red and Licking rivers, and across the Ohio to the mouth of the Scioto. Trails led off from the "Warrior's Path." A well known path extended from the crossing at Red River up that stream and its tributaries to the headwaters of the Licking River. Still another trail led past Richmond, through a pass in the knobs to Irvine, then up the Kentucky River to the three forks near Beattyville and up the North Fork and its tributaries into Perry County and on to Pound Gap. A path destined to be of importance to the whites when they came into Kentucky was a Buffalo trace which, according to Mary Verhoeff, the historian (Ref. 117:62), "left the Cumberland River and 'Indian Road,' near Flat Lick, Knox County, ran along the broad divides between the Laurel and Rockcastle rivers, crossed the Rockcastle to Dick's River, passed through Crab Orchard Gap to Salt River, and thence to the Falls of the Ohio near the present site of Louisville."

G. K. K.—6

There are many more of these trails, but the ones mentioned show that these paths followed the streams and divides, and took advantage of the Gaps in the Knobs. Today the white man's roads, along certain trails his railroads, follow approximately the same routes as these early paths of the buffalo and the Indian. The physiography of the region thus influenced, in a similar manner, the routes of travel of both primitive and highly civilized man.

In 1673 Gabriel Arthur, a Virginian, while making his way along the south shore of the Ohio River in what is now West Virginia, discovered the region now known as Kentucky. As time went on a number of white explorers, including Walker and Gist, penetrated into this territory. Several of the early English expeditions to colonize North America included the area of Kentucky in their charters. In 1767, John Findlay made his way into and out of Kentucky. His accounts of the region awakened the interest of Daniel Boone, who accompanied Findlay and others in an expedition in 1769, and on June 7 they reached the Red River. In both of these journeys Findlay followed the "Warrior's Path."

White settlers began to make their homes in the Wilderness. The Cumberland Gap route became the "Wilderness Road." Daniel Boone with a party of men, marked out a trace which ran "from the Watauga River in East Tennessee (Sycamore Shoals, Carter County), by the way of Long Island to Moccasin Gap near Gate City, where it met the Big Road from Philadelphia and Richmond, and extended along the old trail to Powell Valley through which it passed to Cumberland Gap (Ref. 117:78). From here Boone followed the 'Warrior's Path,' across the ford of the Cumberland just below Pineville Gap and down the Cumberland to Flat Lick. At this place, he left the main trail and took the old Buffalo Trace which led cross-country to the Hazel Patch near Rockcastle River, and then continued up Roundstone Creek," to Boone's Gap, shown in the accompanying photograph, Plate XXXVIII. Crossing Boone's Gap the trail reached the head of Brushy Fork of Silver Creek which flows into the Kentucky River. The ascent to Boone's Gap is rather short and steep on both sides and in

modern times the Louisville & Nashville Railroad tunnels through the knob over which the trail passed. Continuing northward, the path passed where the town of Berea now stands and on to Fort Estill. It ran about two miles east of Rich-

PLATE XXXVIII. BOONE'S GAP.

The trail followed through the Knobs by Daniel Boone is now the route of the Louisville & Nashville Railroad which at the Gap tunnels through the knob. The railroad can be seen in the photograph stretching away to the southward into Rockcastle County. The monument marking Boone's trail is shown on the left.

mond, down Central Fork of Otter Creek and Otter Creek to the Kentucky River where Fort Boonesborough was built (Ref. 92, and 117:78).

In 1775 Benjamin Logan left the main Boonesborough route about two and one-half miles northwest of the present town of London, and turning west crossed the Rockcastle near the mouth of Skegg's Creek, passed through Crab Orchard Gap, and built a station, St. Asaph, near where Stanford is now situated, This path became a very important route into Kentucky. It continued through Crab Orchard, Danville, Harrodsburg, Bardstown, the Salt Works near Shepherdsville to the Falls of the Ohio. The site of the town of Brodhead was an important station on the trail; eight miles from Brodhead was English's Station, and three miles further, Crab Orchard (Ref. 92, and 117:82, 83).

Throughout these days of exploration and settlement, the whites were constantly harassed by the Indians, and many on

both sides were killed. Numerous courageous acts were performed by those brave men and women of early Kentucky. They were of the best blood of Great Britain and founded a race of high type Americans, At the present time, in the more isolated Knobs and Mountains where other races have not as yet settled to any extent, one is struck with the English, Scotch and Irish names of the inhabitants, and their thorough early-American appearance.

Eventually, the four routes along which the settlers had come and commerce had been carried on in eastern Kentucky, became the main wagon roads. These routes were the Wilderness Road, Big Sandy Trail, Red River-Pound Gap Trail, Kentucky River Trail to Pound Gap by way of the North Fork of the Kentucky River (Ref. 117:102). Still later, railroads penetrated the Knobs through the Gaps made by the Kentucky, Red, Licking and Ohio rivers, and followed along the Wilderness Road, cutting the Knobs at Boone's Gap, and the Gap in the southern knobs.

Towns were founded and developed near the Gaps in the Knobs where the Indian trails and eventually the railroads crossed from the Bluegrass to the Mountains. Thus Berea and Richmond, Madison County, are near Boone's Gap and a Pass at what is now known as Big Hill. Mt. Vernon, Crab Orchard and Stanford are near Crab Orchard Gap. Irvine is situated near where the Kentucky River enters the Knobs, Clay City, Stanton and some other towns in that vicinity are along the gateway formed by the Red River. In these towns Mountain and Bluegrass goods meet and exchange is made. Even today, the Mountain people drive their cattle and haul their other commodities to these towns at the gateways to the Mountains. And they return to the hills with other commodities secured by purchase or trade.

While the trails were being developed into roads and railroads, the State of Kentucky was formed. Prior to December 31, 1776, Kentucky was a part of the County of Fincastle, State of Virginia. On that date, Fincastle was divided into three counties of which one was called Kentucky. In May, 1780, Kentucky County was divided into three counties: Jef-

ferson, Fayette and Lincoln. Thus two of the Knob counties came into existence (Ref. 18, v. 2:25). Boundaries were determined mostly by geographic features. Jefferson County, named after Thomas Jefferson, included "that part of the

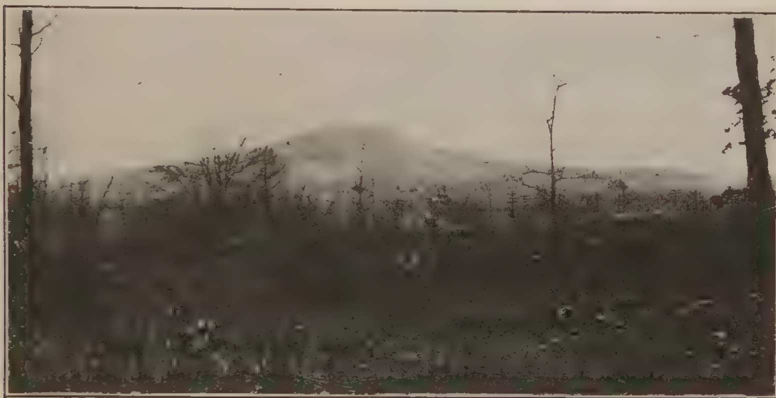

PLATE XXXIX. KNOB TOPOGRAPHY, BULLITT COUNTY.
View looking southeast in northern Bullitt County.

south side of Kentucky River which lies west and north of a line beginning at the mouth of Benson's big creek, and running up the same and its main fork to the head; thence south to the nearest waters of Hammond's Creek, and down the same to its junction with the Town Fork of Salt River; thence south to Green River, and down the same to its junction with the Ohio. Fayette County embraced that part which lies north of the line beginning at the mouth of the Kentucky River, and up the same to its Middle Fork to the head; thence southeast to the Washington line. (Washington line was what is now the boundary line between Kentucky and Tennessee. In the colonial assembly of North Carolina in 1776, the then territory of Tennessee was represented by deputies as the District of Washington)" (Ref. 18, v. 2:25). Lincoln County covered the remaining portions of Kentucky County.

Each of these three counties has been subdivided and many new counties formed. The development of the Knob counties in the order in which they were created as they exist today, is here given.

Counties in Order of Formation	Date Formed	Counties from Which Formed	For Whom Named	Present Area in Sq. Mi.	County Seat
Jefferson	1780	Kentucky	Thomas Jefferson	387	Louisville
Lincoln	1780	Kentucky	Gen. Benjamin Lincoln (officer in Continental Army)	338	Stanford
Nelson	1784	Jefferson	Thomas Nelson (ex-governor of Virginia)	411	Bardstown
Madison	1785	Lincoln	James Madison	446	Richmond
Clark	1792	Fayette, Bourbon	Gen. George Rogers Clark	265	Winchester
Bullitt	1796	Jefferson, Nelson	Lieut. Gov. Bullitt	308	Shepherdsville
Montgomery	1796	Clark	Gen. Richard Montgomery	198	Mt. Sterling
Garrard	1796	Mercer, Lincoln, Madison	James Garrard (Governor of Kentucky)	237	Lancaster
Fleming	1798	Mason	Col. John Fleming	325	Flemingsburg
Lewis	1806	Mason	Capt. Meriwether Lewis	491	Vanceburg
Estill	1808	Madison, Clark	Capt. Jas. Estill	254	Irvine
Rockcastle	1810	Lincoln, Pulaski, Madison, Knox	Rockcastle River	310	Mt. Vernon
Bath	1811	Montgomery	Medicinal Springs	270	Owingsville
Oldham	1823	Jefferson, Shelby, Henry	Col. Wm. Oldham	180	LaGrange
Marion	1834	Washington	Gen. Francis Marion	345	Lebanon
Boyle	1842	Mercer, Lincoln	Ex-Chief Justice John Boyle	186	Danville
Powell	1852	Montgomery, Clark Estill	Lazarus W. Powell (Gov. of Ky.)	181	Stanton
Rowan	1856	Fleming, Morgan	Judge John Rowan	272	Morehead

While these counties were coming into existence the country was developing in every way. The level, more fertile lands of the river bottoms in the Knobs, were taken up first by settlers, who then gradually pushed further upstream. And at last, they spread out over the steep, more infertile slopes of the surrounding knobs which at present are still being cleared, cultivated, and abandoned to undergrowth and soil erosion. Towns sprang up, roads were constructed and improved, railroads came connecting parts of the Knobs with one another and with the large markets of such cities as Lexington, Louisville, Cincinnati, Knoxville, Nashville, Cleveland, Pittsburg, New York and Chicago. The Kentucky River was made navigable to Beattyville, and boats go upstream somewhat beyond this town. Railroads parallel the larger rivers in the Knobs, and draw a great deal of the traffic to themselves which otherwise would go by river boat.

Public schools were established in the towns and rural districts. Academies, normal schools, trade schools, and colleges were founded. Towns macadamized their streets and installed electric lighting systems and municipal water works. Many fine residences were built. But great as has been the development of the Knobs up to the present time, enormous undeveloped natural resources yet remain.

CHAPTER VIII

LIFE CONDITIONS IN THE RURAL DISTRICTS

Life conditions in the rural communities of the Knobs are determined largely by the geology, physiography and soils of the regions; for upon these factors depend the food supply, cash crops and other farm products. Differences in climate throughout the Knob Belt are slight.

The better Knob farms are found in the richer, more level, limestone areas that form the inner margin of the Knobs. Productive farms are also found on the uplands that are underlain by limestone; while on the poor soils of the Ohio shale and hilly, stony soils of the knobs in general are located the less prosperous farms. But occasionally good farm houses and buildings are seen on the Ohio and Waverly formations, for the bottom lands bordering the creeks have belts of rich soil. In some instances better living conditions are the direct reflection of the recently acquired knowledge of how to make the Ohio and other shale soils yield an adequate return for the money and labor invested.

Housing conditions, however, usually vary with the fertility of the underlying formation. At one extreme are large, well painted, two story farm houses, sometimes with two story porches; and excellent log houses. In the Bluegrass sections are seen the imposing plantation houses of the Old South, with their great white pillars, surrounded by beautiful lawns, and numerous farm buildings in the background.

In the Knobs, especially on the Ohio shale soil, are found the one room log cabins, Plate XL, unpainted box houses and board shacks. Some of these are windowless, the only light and ventilation entering the dark interior through the door or chinks in the walls and floors. The custom of building windowless houses is said to have originated in pioneer times when Indians or other marauders could have shot through a window at the people within the cabin. The poor box dwellings predominate in some localities, being clustered near each other because of the small size of the land holdings. In other places homes are widely dis-

tributed, fine houses with large farms being the common type of dwelling.

The materials from which the houses are made have been influenced by the topography and the industrial development of the region. The very old dwellings were constructed of logs, but

PLATE XL. A LOG CABIN OF THE KNOBS.
Near Narrow Gap, southern Madison County.

with the advent of the sawmill and the decreasing supply of timber, frame houses both large and small became the rule, although log houses are still built. In the hilly and mountainous knobs today are found more log cabins than on the more level areas. This is due to the forests still remaining on portions of the steep slopes, while the timber was first cut off the level areas which now, in places, are several miles from the forested districts. Consequently logs at present can be obtained near at hand in the rougher knobs with which to build log houses, while they would have to be transported a number of miles in many cases if they were used in the level territory. But even with this geographic influence exerting itself upon the type of dwelling, frame houses are now being built extensively in the hilly knobs.

One room log cabins have a frame shed built on to the back of the main structure to serve for a kitchen. The one room of the cabin proper contains the double bed, chairs, table, lamp and large stone fireplace. There may be a spinning wheel to

add beauty to the interior, for the older women especially are expert in the art of spinning. A low loft has been built above the main room of some of the cabins. Heating is accomplished with an open fire in the fireplace, with a stove, or both stove and fireplace. Cooking is done usually on a stove, though the fireplace may be used, also.

Another type of log house consists of two separate one-room dwellings, each room about fifteen feet square, although the size varies, with an out-of-door covered passage between the two rooms. To go from one room to the other a person has to walk out of doors beneath the connecting roof and enter the other room from the open air. This is a rather chilly procedure in winter, though once inside a room, it is warm enough as each room has a door.

The houses can accommodate an unbelievable number of people. One box house in the Knobs consisting of one room about fourteen feet by eighteen feet, according to E. L. Dix, of the Red Cross, sheltered fourteen individuals, comprising the father, mother, mother's parents, and ten children. Ventilation and light were obtained through the front and back doors, and one window. The room contained three beds (two double and one single bed) placed side by side at one end, a table, chairs, and a sewing machine. This case is extreme, but living conditions are far too often overcrowded.

Sanitary conditions with respect to toilet accommodations are often very poor. In some sections of the Knobs over half of the families have no toilet at all. When present, the toilets are often broken down sheds where flies and animals can enter and carry the pollution away on their feet, thereby spreading typhoid, hookworm, and other diseases if present. For the welfare of the people of the Knobs such unsanitary conditions cannot be remedied too soon.

Many of the people in the poorer districts can neither read nor write. They often are listless and seem to lack ambition, but this is due generally to malnutrition, hookworm, and other diseases. Others in these areas are perfectly willing to work, but their farms on the Ohio shale soil need humus, lime, drainage, and various fertilizers in order to produce crops of eco-

nomic value and these people are so poor and ill advised as to what is necessary to improve the farm land that they derive a very meager income. They have large families to care for which often prevents the head of the family from having enough extra money with which to buy seed and commercial fetilizer, even if he understood exactly what he should purchase. In such instances the land is cropped over and over with constantly diminishing returns. The women put up a noble fight against their geographic environment to keep the family in food and clothes. The entire family works in the small tobacco patch and corn field; and when near a town the older members secure occasional employment. They usually are of mountain stock and pure blooded Americans, although here and there people of foreign extraction have drifted in and settled in the Knobs.

The common diet of the inhabitants of the Knobs consists of: Corn bread, the corn usually being raised by the family and ground in the local mill; soda biscuit; meat, often pork from hogs raised on the farm is eaten fresh at the time of butchering and preserved as salt pork for the rest of the year; vegetables from the home garden, fresh in season, and in some places preserved by home canning, drying or storing methods. Tomatoes, beans, and potatoes are among the most commonly preserved vegetables. Many homes, however, do not lay away enough home grown vegetables to last until next year's crop comes again to replenish the larder. Wild blackberries are picked and eaten fresh in season and to some extent preserved. Strawberries also are raised and preserved.

Poultry is found on all farms, but too often practices of underfeeding and inadequate housing result in an egg yield per hen that is only a fraction of what it should be. It pays in dollars and cents to take good care of the poultry. If treated right they will repay their cost many times over. Eggs and poultry are often sold rather than eaten on the farms, especially when poultry products bring a high price.

Sorghum is grown for sirup to be used on the home farm, though it is sometimes sold and commercial syrup purchased at the local store.

Milk and butter are produced on the vast majority of the farms, but many families rarely use butter. Even the poorest

families with only a small garden and yard around their box house or cabin, usually have a cow which they pasture on vacant land or in a neighbor's field. This pasturage is paid for at a very small cash rental, or in labor.

PLATE XLI. ONE TYPE OF BARN.
This inadequate shelter is passing as the Knobs develop, and excellent barns are taking its place. Photo by Robt. Spence.

Of the foods described above, corn bread, soda biscuits, salt pork or bacon, and milk are the staple diet. When a guest is present, the generous housewife will place upon the table butter, eggs, and all of the preserved fruits which she has in the larder in addition to the usual items of the menu as mentioned above.

The outbuildings on the better farms include a barn, occasionally 40 feet by 60 feet, which may be used in the fall to cure tobacco, and in winter to house the live stock. Barns about 30 feet by 40 feet, are of more frequent occurrence; while smaller barns are even more numerous. The roofs of the barns are sometimes projected at the end over the doorways, and thus afford partial protection from rain for livestock and farm implements which may be beneath. The poorest barns are mere log or board sheds with open cracks through which the rain or snow can enter, Plate XLI. The corn crib is not connected with the barn. This is to insure against loss of the corn by fire in

case the barn is burned. The greater portion of the hay is stacked in the field, the remainder being placed in the barn.

The fences formerly were all wooden. One old inhabitant stated that at first the crooked (or snake) rail fence was the most common. This was when wood was plentiful. Then as the forests were cut away, the straight rail fence was constructed. They often were built of material from crooked fences. At present, the old wooden fences are repaired with wooden rails, or wire, but new fences generally are of wire, both in the level and hilly parts of the Knobs. Considering both the old and new fences, there are now more wooden fences to be seen in the forested, hilly parts than in the level Ohio shale and Silurian areas nearer the Bluegrass which contain comparatively few trees.

The farmer's water supply is obtained from springs, streams, open and drilled wells, the latter type of well being the most common nowadays, though wells are still dug. These open sources of water are liable to become contaminated. Water from an open well is drawn by a rope and bucket, a wellsweep or windlass. The drilled wells are more sanitary than the open wells, but even these drilled wells can become polluted by movement of contaminated ground water, by bacteria entering from the top of the well, or on the "sand bucket" which, when not in use, is often placed on the ground beside the well.

The live stock are watered in the creeks and at the springs along the hillsides. Small ponds are formed by making a shallow excavation in the field which becomes filled with ground surface water. Sometimes a brook is dammed to form a pond. In very dry weather, the springs and smaller creeks on the knob sides dry up. The stock then have to be driven to the larger streams in the valleys. Here there generally is plenty of water, for the deeper holes often contain water even when other parts of the creek have dried up. In extremely dry periods of the autumn months, these deep holes may lose so much of their water that the live stock are driven considerable distances to yet larger streams where water can be found.

The country people go to the nearby villages or towns on Saturday to sell their farm products and to shop, just as they do in any rural community in the United States. They are

very fond of politics and a "public speaking day," when a political orator addresses the crowd, is a social occasion which is well attended and greatly enjoyed.

"Court day" at the county seat is an important event both socially and for trade. Even the farmers who live in the hills quite a distance away, come in to town driving their live stock which they wish to sell, or trade for other commodities Stock pens at the county seat promote the bringing in of live stock.

The usual mode of travel in the rural districts is by wagon, or on saddle horse or mule. The inexpensive, light weight automobile is also often seen. It has brought the people to some extent into closer contact with each other and with the townfolk. This has lessened the isolation of the farms. The roads, however, during the winter are very bad except on those roads that are "piked." During more favorable weather if the automobile can go at all with chains through the mud on the dirt roads it has an extremely difficult time. Along the macadamized roads the automobile serves the farmer in an efficient manner throughout the entire year. Many social, educational, and economic advantages go with the use of the motor car in the Knobs region. The United States Mail Service has extended its Rural Free Delivery through the district and this has also brought the people into closer contact, especially through the daily newspaper, with the outside world. The radio has brought entertainment and educational features into many homes.

Illiteracy exists in all of the Knob counties; an illiterate, as defined in the Fourteenth Census of the United States, being a person ten years of age or over who is unable to write any language, not necessarily English, regardless of ability to read. In the Knobs many can neither read nor write. The Knob counties, as a whole, in 1910, had 9.2 per cent illiterates; in 1920, 6.4 per cent, as against the State average in 1910 of 12.1 per cent; 1920, 8.4 per cent. Thus the Knob counties during this decade had a lower per cent of illiteracy than the State as a whole.

The rugged Knob counties contain a higher per cent of illiteracy than the more level Knob and Bluegrass counties with

their better roads. For example the illiteracy in the hilly Knob counties in 1910 and 1920 was as follows: Estill, 1910, 20.3 per cent, 1920 13.2 per cent; Powell, 20.2 per cent, 12.2 per cent; Rockcastle, 17.4 per cent, 13.6 percent; Rowan, 18 per cent, 6.2 per cent. Illiteracy in the more level Knob counties in 1910 and 1920 was as follows: Jefferson, 5.6 per cent, 4 per cent; Oldham, 8.7 per cent, 6.3 per cent; Clark, 9.6 per cent, 8.8 per cent; Madison, 12.9 per cent, 10.2 per cent. The same principle holds true for the remainder of the Knob counties, namely, that a smaller per cent of illiteracy occurs in the more level counties and a higher per cent in the rugged areas. The decrease in illiteracy during the decade of 1910 to 1920, for each of the Knob counties is encouraging and should be maintained until illiteracy in the Knobs is a thing of the past.

The rural schools are the fundamental force with which to eradicate illiteracy in the country districts. At present the school houses are often small. Some are painted white and are attractive in appearance; others are in need of paint and appear poorly lighted and ventilated. The toilet facilities often are not good.

The school year now extends from about the middle of July to some time in January or the first part of February, a total of about seven months. The date of beginning and closing the school year varies a few days in actual practice according to local conditions. The school commences in July because by that time the rush of planting and cultivating the corn on the farm has subsided. It closes in January or February because after that date, if not before, the rains and snows have reduced the "dirt" roads to quagmires. Along the "piked" roads, which are few in number, conditions remain good. Since the school is in session in July and August the children unfortunately have to attend during the two very warm months of the year. Schools in the northern States avoid this unfavorable mid-summer period by beginning in September. But in the Knobs it is unavoidable. Roads are a fundamental factor in the educational betterment of the Knobs and Mountains. Better roads are an absolute necessity for the development of the country districts.

In the towns and cities the public school buildings sometimes are of brick and present a good appearance. High schools are located at various points throughout the Knob Belt. Libraries are doing an excellent work in educating the people of the Knobs who are fortunate enough to live nearby. For example, the Berea College Library, Miss E. K. Corwin, Librarian, reaches out to the people of the surrounding Knobs. Mrs. Florence H. Ridgway is the present Director of the Extension Work of this library, which was founded by Prof. A. E. Todd about 25 years ago. At first cases each containing 15 to 25 books were sent solely to Mountain schools. Seven years ago a book-wagon drawn by two mules commenced visiting the Knob homes. Three routes were covered. The longest circuit totalled 18 miles; the second, 14 miles; the third, 12 miles. The wagon did one of these trips in a day. A short visit was made at practically every home, 25 to 30 families being seen per day. Two to twelve books, depending on the size of the family and their interest in reading, were left at each house. The books which had been left on the preceding visit were collected. Each trip was made once in four weeks. This schedule gave a family a fresh supply of books about every month.

Within the last year this book-wagon work has been discontinued. In its place home reading circles have been organized. One person in a Knob community is given charge of a collection of books. The neighbors come to this person and secure the books desired, returning the books which they have read, to the individual in charge. Each circle ranges in size from three to forty families. During the first four months of the current year ten reading circles were being furnished with books. One hundred and thirty-five families thus were supplied with literature, and 800 books were placed in circulation. An automobile takes a new set of books to each center once a month. In addition to the reading circles, seventeen rural schools are supplied with books and pictures. The pictures are of beautiful scenery, historical and religious events, and similar subjects. The pictures are kept in the school and changed monthly.

Preparatory schools and colleges have been established in a number of the Knob counties, either in or near the Knob Belt. A list of these institutions of learning in the Knob Belt proper is given in Table 23.

PLATE XLII. AIRPLANE VIEW OF BEREA COLLEGE.

1. Chapel. 2. Library. 3. Lincoln Hall. 4. Ladies' Hall. 5. Academy Buildings. 6. Industrial Buildings. 7. Foundation Buildings. 8. Power Plant. 9. Boone Tavern. 10. Union Church. All buildings not shown. Photo by C. I. Ogg.

Several Roman Catholic schools were established in Marion, Nelson and adjacent counties many years ago. Among these institutions are Loretta Academy, established in 1812 at Loretta, Marion County; Gethsemane College, men, Nelson County; Nazareth Academy, Nazareth, Nelson County. The members of these schools and institutions have done a wonderful work in causing the comparatively unproductive soil to bear luxuriantly. The Trappist monks have long been noted for their beautiful gardens. At Ottenheim, Lincoln County (Ref. 82:186) a German colony has also done excellently with the naturally poor soil.

Widely known among the non-sectarian, co-educational centers of learning, is Berea College, Berea, Madison County, Plate XLII. This school was established in 1855. It is built on a flat topped ridge of the Ohio shale, a part of the old Lexington peneplain. The attendance in 1921-1922 totalled 2,600 students. The entire institution includes the College, Normal School, Academy, Junior High School, Foundation, and Music Schools. No tuition is charged, thereby enabling many of the young people of the Appalachian Highlands who could not otherwise secure an education, the opportunity to obtain thorough instruction. The geology and geography courses in Berea College, proper, are of great benefit to the mountain men and women in teaching them concerning the natural resources of their homeland. The college campus covers 140 acres, gardens 50 acres, college farm 494 acres and Berea forest reserve 5,162 acres. A reservoir in a narrow valley between two knobs has a capacity of 11,000,000 gallons of water, and assures the college and town of Berea a water supply even during the dry Autumn months. This reservoir is supplemented by ten small reservoirs fed by mountain springs. The college has its own electric, heating, and ice plants; water, sewerage, and telephone systems; broom factory, dairy, farm gardens, cannery, bakery, hospital, laundry, print shop, blacksmith shop, carpentry and paint shops, post office and cooperative store. Dr. Wm. J. Hutchins is president.

HEALTH CONDITIONS

Health conditions in the Knobs, Bluegrass and "Mountains" are best shown and comparison made between these physiographic divisions in the tables of mortality statistics for the various diseases of most importance. Mortality statistics given in this report were furnished through the courtesy of J. F. Blackerby, State Registrar, Kentucky State Board of Health.

MORTALITY STATISTICS*

Comparison of State and Physiographic Divisions for
TUBERCULOSIS, TYPHOID FEVER, PNEUMONIA, CANCER, DIPHTHERIA, DIARRHOEA (under 2 yrs.) WHOOPING COUGH.
Average death rates per 100,000 population for 10 years (1911-1921).

	Tuberculosis	Typhoid Fever	Pneumonia	Cancer	Diphtheria	Diarrhoea (under 2 yrs.)	Whooping Cough
State of Ky.	180.1	29.3	124.2	49.5	16.2	47.0	17.3
Blue Grass	201.8	28.7	129.2	62.4	15.1	45.6	18.4
Knobs	167.7	32.1	103.3	40.8	21.6	49.3	16.9
Mountains	106.9	30.9	89.2	20.9	21.5	47.6	19.1

*For statistics relative to remaining Physiographic Divisions, see reference 9, p. 194.

MORTALITY STATISTICS

TUBERCULOSIS. TYPHOID FEVER, PNEUMONIA AND CANCER.
Average death rates per 100,000 population for 10 years (1911-1921).
KNOB SECTION.

County	Tuberculosis	Typhoid Fever	Pneumonia	Cancer
Bath	209.8	35.6	106.8	35.6
Boyle	210.5	38.5	145.7	69.7
Bullitt	164.0	21.1	122.0	47.4
Clark	219.8	38.1	134.0	58.0
Estill	126.1	19.5	93.0	16.3
Fleming	193.0	30.9	121.8	47.0
Garrard	210.9	26.0	125.8	37.8
Jefferson	230.0	16.7	167.1	82.1
Lewis	183.5	41.2	96.6	39.8
Lincoln	205.2	40.8	135.2	64.1
Madison	178.0	31.3	109.1	47.6
Marion	177.0	37.3	126.5	41.1
Montgomery	205.6	23.8	112.0	83.1
Nelson	219.5	39.7	129.8	66.2
Oldham	176.9	19.1	134.5	66.8
Powell	132.5	9.2	38.2	15.4
Rockcastle	135.0	29.3	77.0	23.1
Rowan	172.1	45.8	82.0	26.5

In the three physiographic regions the highest death rate from tuberculosis occurs in the Bluegrass, with the Knobs second, and the Mountains third. The explanation is that the

more congested the population and sedentary and indoors the life of the people, the higher the death rate from this disease. The out of door life of the Knob people is sufficient to keep the death rate of the Knobs at 167.7 compared with the State average of 180.1.

One of the breeding places of tuberculosis in the Knobs is the ill-lighted and poorly ventilated one room dwelling. Education and sanitary inspection by the proper authorities will no doubt greatly remedy these conditions and be a blessing not only to the people themselves, but also to the more prosperous inhabitants of the Knobs whose health is endangered by these unsanitary dwellings.

It should be clearly noted, however, that unsanitary premises do not exist everywhere throughout the Knobs. When they do occur they generally are on the Ohio shale, and to a far lesser extent on the Waverly shale, though cabins without windows and with no sanitary arrangements are found in the Pottsville areas on the tops of some of the Knobs, and on other formations.

Typhoid fever is slightly more prevalent in the Knobs than in the Bluegrass or Mountains. The reason may be that in the Mountains the dwellings are more scattered; and therefore typhoid bacteria in a polluted stream or germs carried by flies, are not so readily distributed as in the Knobs where the houses often are clustered closer together. Lack of fly screened toilets aids the spread of typhoid and should be remedied. The use of streams, springs, open wells which may become polluted, and of contaminated buckets or drinking utensils, and of drilled wells which obtain their water from sources which are subject to pollution, all are causes of typhoid fever in the Knobs. The better sanitary conditions of some of the Bluegrass cities cause the typhoid death rate to be lowest in this physiographic division.

The pneumonia death rate is highest in the Bluegrass, with the Knobs second, and the Mountains third. Here again the congested, indoor life of the people is shown in the death rate. In the Knobs, the lack of proper ventilation, especially in the

one room dwellings, causes more deaths by pneumonia than might otherwise occur.

Diseases not mentioned in the tables given in this report, but which nevertheless are a source of ill health and suffering to the inhabitants of the Knobs are hookworm and trachoma, the latter being a contagious eye disease which is spread chiefly through the use of the family wash basin, soap and towel. These ailments occur in practically every county of the State. Hookworm exists because the climate and soil are favorable, and sanitary conditions, especially in the rural districts, are often bad. It is a very easily cured disease and its eradication will mean an immense increase in the industry of thousands of people in the rural areas. This will, also, cause an immense increase in wealth produced in the State. Free literature describing these and other diseases and telling how they are contracted and cured, may be secured upon request from the Kentucky State Board of Health, Louisville, Kentucky.

Ownership of the Land

The number of farms worked by tenants in the Knob counties is influenced by the physiography of the region. The more hilly and mountainous counties, with their low average value per acre, do not have nearly so high a percentage of tenants on the farms, as do the counties containing large areas of level Knob and Bluegrass land of much greater value per acre. The reason is that it is difficult for the land owner himself to make a living from the soil in the more infertile, mountainous areas; and for a tenant to make a living and pay the land owner also is too hard and often an impossible task for many to undertake it. The mountainous land is cheap compared to the level limestone areas and there is little labor saving machinery possible in the rugged districts. Thus it is easier for the poor man to buy a farm and work it himself in the hilly regions, than it is in the richer territories. In the level or rolling Knob and Bluegrass portions of the Knob counties, tenancy is increasing because as land rises in price, it becomes more difficult for the man who does not have much capital to buy a farm. Also it is more desirable to rent a farm at inter-

est rates lower than he would have to pay if he borrowed the money to buy the farm.

In illustration of the above principle, Rowan in 1910 had 281 tenants; 1920, 244 tenants and an average land value of $10.10 per acre, only 18.7 per cent of all farms being worked by tenants. Powell in 1910 had 274 tenants; 1920, 182 tenants and average land value of $18.30 per acre, 21.6 per cent of all farms being worked by tenants. The other hilly counties in general show the same relationships. On the other hand, Clark County in 1910 had 573 tenants; 1920, 703 tenants, with land values averaging $147.82 per acre and 42.5 per cent of all farms worked by tenants, which was the highest per cent of tenancy in any Knob county. Boyle County in 1910 had 308 tenants; 1920, 544 tenants, with average land value of $121.36 per acre and 39 per cent of all farms worked by tenants. Jefferson County in 1920 had 29.4 per cent of all farms worked by tenants, with an average land value of $121.19 per acre. This smaller per cent of tenancy, but with a high average land value, is due to the nearness to Louisville and the intensive farming that is practiced in this county, numerous farmers caring for their own truck farms. Tenancy by counties is given in Table 24 of the Appendix.

Taking the Knob counties as a whole, tenancy increased 36.3 per cent during the last twenty years. In 1920, 31.5 per cent of all Knob county farms were worked by tenants. Tenancy in the mountainous Knob districts never will be a problem as the physiographic environment prevents its developing; but in many of the more level, fertile Knob and Bluegrass areas with their high priced land, tenancy is increasing.

Regarding the nativity and color of the farm owners and tenants in the Knob counties we again find the geographic influence. In the more level counties such as Clark, 57 per cent of the native white farmers worked their own farms; Madison County, 63 per cent. In the more hilly counties, Powell, for example, had 77 per cent and Rowan County, 81 per cent of the native white farmers operating the farms which they owned. In the Knob counties in 1910, 64 per cent of the native white farmers operated their own farms; 1920, 68

per cent. The State average in 1920 was 67 per cent. The Knob counties as a whole in 1920 had 68 per cent of the foreign-born white farmers working the farms which they owned; State average in 1920, 66 per cent. Fifty-seven per cent of the negroes and other non-white farmers in the Knob counties in 1920, worked the farms which they owned; State average 42 per cent.

The few tenants which the mountainous counties have are nearly all native white; the greatest number of foreign-born white tenants are in Jefferson County where truck gardening is carried on; and negro tenants are in greatest numbers in the level Knob and Bluegrass areas.

CHAPTER IX

HIGHWAYS AND TRANSPORTATION

Many of the trails of pioneer days have been widened and improved into wagon roads, and in addition numerous other public highways have been built. In the hilly and mountainous sections of the Knobs, the topography directly influences the location of the roads. They generally follow the valleys, and to a lesser extent the higher land of the river divides when the ridges are of sufficient length and run in the requisite direction. In the wet season of the year these higher roads are preferred because they dry off much more quickly than those that wind along beside the creeks. In the rainy portions of the year these creek roads sometimes are impassible for loaded wagons. The people, however, ride horseback a great deal and thus get through when a vehicle would be mired. Even in dry weather, these roads are very rough, with great holes here and there which have been caused by washouts. On either side of the narrow, V-shaped valleys the knobs tower in the wilder regions to almost mountainous proportions. Roads leading up the sides of the knobs to reach the divides at the crest, do so with numerous turns to reduce the grade. Gaps between the knobs serve as passes through which roads connect the lowlands of the Bluegrass and the highlands. In the level, or rolling Devonian-Silurian limestone strip bounding the Bluegrass, the country is much more accessible in all directions and the roads are not so greatly influenced by the topography as in the rougher areas.

Dirt roads on the Ohio and Waverly shales are dusty during the dry seasons and sticky with mud in the wet periods of the year. When in the latter condition they make difficult work for a team and are slippery for automobiles. Shale is used in places to mend the roads, but it is not permanent and soon breaks down into fine pieces giving dust or mud according to the season. Gravel from the weathered Pottsville conglomerate, or stream channels when near at hand would make a far

better road material. The Mammoth Cave limestone in the hilly sections where it occurs, and the Devonian and Silurian limestones nearer the Bluegrass are quarried, crushed and used as road metal. They make excellent roads with a suitable binder, but wear away rather easily. Roads on the Pottsville ridges are sandy or gravelly and dry off readily. The main highways sometimes are "piked," crushed limestone as mentioned above, being used. Bituminous macadam roads have been built in a few of the Knob counties.

The older roads along the creek margins in the hilly regions often are so narrow that two teams or automobiles cannot pass, one team being obliged to wait at a wider spot in the road until the other has passed. Abrupt drops ranging from 10 to 150 feet on one side of the remote country roads sometimes occur. Bridges are rare except on the main traveled roads, traffic being obliged to ford the streams.

The well known highways that cross the Knob counties are as follows: (1). The *Dixie Highway* leads south from Cincinnati through Richmond, Madison County; thence south to Berea along the road passing just east of the Berea College campus, and on over the knobs out of Madison County into Rockcastle to Mt. Vernon, where it intersects with the *Boone Way*. Some changes may be made in the route.

(2). *The Boone Way* leads from Cumberland Gap northwest to Corbin, thence to Mt. Vernon and continues northwest through the knobs to Crab Orchard, Danville, Bardstown, and Louisville.

(3). *The Atlantic Pacific Highway* and the *Midland Trail* lead from Louisville eastward to Lexington and continue through Winchester, Mt. Sterling, and in the Knob belt through Owingsville, Farmer, Morehead, to Catlettsburg.

Numerous lesser automobile trails connect various towns within the Knobs. In addition to the public roads, there are many miles of private roads.

The highways in the Knobs should be improved as rapidly as possible. To leave the dirt roads in their present condition is a serious economic, educational and social loss to the people.

A few of the advantages of good roads are: Increase in land values; saving in time and energy of men and teams hauling goods over fine roads as compared to poor roads; reduced wear and tear on wagons and harnesses; ability to market crops when desired, thereby often securing a higher price for farm products than might be obtained if the commodities were taken to market mostly at a few periods of the year when the roads permitted; more trade for town merchants; larger school attendance; higher standard of instruction where small schools are consolidated into one large school for the district, this being possible with good roads; closer social intercourse among the farmers; more frequent attendance at church and social meetings.

Automobile bus lines have developed rapidly and by 1925, an hourly schedule is maintained between many of the principal towns of the State.

River Navigation

In former days logs were floated separately and in rafts from the mountains and knobs down the Kentucky River to the sawmills in the Knobs and Bluegrass. At present the Kentucky River by a system of dams and locks has been made navigable for boats to slightly above Beattyville. Coal is taken out of the mountains by barges propelled by steamboats, Plate XLIII. Log rafts are towed down stream to the sawmills.

PLATE XLIII. NAVIGATION ON THE KENTUCKY RIVER.
Steamboat pushing barge upstream near Irvine, Estill County.

Oil tank boats carry out petroleum. But the railroads have absorbed a great share of the former river traffic, and pipe lines carry the bulk of the oil.

The Ohio River flows near the north ends of the Knobs; and in the earlier days of Kentucky the towns along the shores were dependent upon the river for transfer of goods to and from the outside world. The development of railroads caused a decline in the river commerce. During the last few years improvements in the Ohio River, together with other factors, have aided navigation and the river traffic again is increasing in volume.

At present, the Louisville & Cincinnati Packet Company's steamers ply between the two cities named. East of Cincinnati the Greene Line Steamers operate. Two steamboats stop daily at Vanceburg. They bring general merchandise and take on board agricultural products and other commodities from the Knobs and Mountains. Passengers are carried on all boats except the coal barge boats and theatre boats. Coal, farm and forest products, together with manufactured and miscellaneous commodities are the principal articles of commerce transported on the river. Fleets of coal barges are floated from Pittsburg and other coal fields, downstream to Cincinnati, Louisville and to markets in the lower Mississippi River Basin. Most of the river traffic, however, is between comparatively local ports.

Railroads

Fifteen railroad systems, including traction companies, serve the Knob counties. The total mileage in these counties for each of these systems in 1915 was as follows: Louisville & Nashville Railroad, 441.27 miles; Chesapeake & Ohio, 133.77 miles; Cincinnati, New Orleans & Texas Pacific Railway Company, 24.35 miles (this railroad is part of the Southern R. R. System); Southern, 23.38; Louisville, Henderson & St. Louis, 16; Kentucky Traction & Terminal Company, 1.14; Cincinnati, Frankfort & South Eastern, 5.60; Baltimore & Ohio, 0.92, Chicago, Indianapolis & Louisville, 1.12; Illinois Central, 20.55; Louisville & Interurban, 80.42; Louisville & Southern Indiana Traction Co., 0.134; Pennsylvania Terminal Ry., 9.72; Moun-

tain Central, 3; Morehead & North Fork, 14.5. In 1915 the total railway mileage for the Knob counties was 776.34. In 1921, it was 794.24 miles. The railroads and their mileage per county are given in Table 25 of the Appendix.

The direction that the railroads extend has been determined to a great extent by the topography. At the north end of the Knobs the Chesapeake & Ohio Railroad passes along the valley of the Ohio River from Cincinnati to Vanceburg, Lewis County, and thence eastward, while to the west of Cincinnati the Louisville & Nashville stretches to Louisville. The north-south traffic is carried by the Louisville & Nashville Railroad lines. The Cincinnati-Knoxville main line of the Louisville & Nashville extends from Cincinnati southward, passing at Boone's Gap through a short tunnel in the Knobs, and on to Knoxville, Tennessee. Connections are made at Paris, Bourbon County, with a branch of the Louisville & Nashville which runs between Lexington and Maysville, situated on the Ohio River. At Johnson, Fleming County, a line branches off to Flemingsburg and Hillsboro, Fleming County, the railroad passing somewhat southeast of Flemingsburg through country underlain by Silurian formations which are Knob strata.

At Winchester the Cincinnati-Knoxville line of the Louisville & Nashville makes a junction with the Chesapeake & Ohio to Mt. Sterling and beyond through the Knobs to Olympia, Farmer, Freestone and Morehead, the gateway through the Knobs being cut by the Licking River system. The railroad from Farmer extends up Triplett Creek. At L. & E. Junction about half way between Winchester and Mt. Sterling, a Louisville & Nashville line goes southeast through the Knobs to Indian Fields and up the Red River valley to Clay City and Stanton, Powell County, and beyond to the east. From Mt. Sterling a branch railroad extends southeast to Frenchburg. From Olympia, Bath County, a line runs to Owingsville, the county seat. Westward from Winchester the Louisville & Nashville goes to Lexington. A Louisville & Nashville branch runs southeast from Winchester to Irvine.

Richmond is a junction for the Louisville & Nashville main line with another of its railroads which stretches from Louis-

ville and Nicholasville southeast through the Knobs to Moberly, Brassfield, Panola and then northeast to Irvine, where it connects with the Louisville & Nashville from Winchester. The railroad continues along the valley of the Kentucky River from Irvine to Beattyville and beyond. The entrance of this railroad line through the Knobs and into the Mountains is through the gap made by the Kentucky River. At Fort Estill the Cincinnati-Knoxville Division connects with a Louisville & Nashville line which runs southwest to Lancaster and Rowland. Near Mullins, Rockcastle County, the Cincinnati-Knoxville line meets the Louisville & Nashville line which runs northwest, passes through the rougher Knobs at a pass near Crab Orchard and on to Rowland, Stanford, and through Knob territory to Junction City, Lebanon, Loretto, Lebanon Junction, Shepherdsville and Louisville. Connections are made at several points along this railroad with branches of the Louisville & Nashville and other lines.

From Junction City, Boyle County, the Queen & Crescent Railroad passes through the Knobs where tributaries to the Dix and Green rivers have lowered the land, and extends south into Tennessee. At Lebanon a railroad runs south to Campbellsville and Greensburg. At Lebanon Junction there is a connection with the Louisville & Nashville railroad which extends between these two cities. At Bardstown Junction a Louisville & Nashville line stretches southeast to Bardstown and Springfield. At Louisville a network of railroads connect with Frankfort, Lexington, Cincinnati, the Western Coal Field and points outside the State. Ohio River traffic also is met at Louisville.

Thus it is seen that the Knob Belt is well served with railroads, although in some areas, such as localities in western Lewis County, there are districts eight to nine miles in a straight line from the nearest railroad. In Nelson County some of the Knob land is six miles from a railroad. Most of the Knob areas, however, are much nearer transportation lines. But even the longer distances are not too great for economic haulage of the farm products to the nearest point of shipment provided the wagon roads are in good condition.

In summary the relation of railroad transportation to the marketing of Knob products is as follows: The main railroad lines extend in a north-south direction, such lines serving both the east and west belts of the Knobs. Branch railroads intersect and traverse Knob territory connecting with the north-south main lines. The western Knob Belt is especially well served in the Knobs proper. The eastern Knob Belt is intersected by railroads entering through river gateways cut in the Knobs, into the mountains beyond. The main north-south line with which these branch railroads connect passes mostly through the Bluegrass except where it tunnels through the Knobs at Boone's Gap. This Cincinnati-Knoxville Division of the Louisville & Nashville, and in the western Knobs the line from Louisville to Nashville reach large cities. At all of these cities connections are made with railroad systems which lead to all parts of the United States. Within the State of Kentucky the cities reached by railroads traversing Knob territory are Winchester, Richmond, Lexington, Frankfort, Louisville and many others. Cities outside the State which the products of the Knobs can reach due to the railroads which serve the Knobs are, for example, Cincinnati, Columbus, Cleveland, Buffalo, Pittsburg, New York City and the other Atlantic seaboard cities, Chicago, Knoxville, Nashville, and many other places which will act as markets for commodities produced in the Knobs. Perishable articles such as fresh eggs, are shipped from Knob towns to New York City, Pittsburg, Cincinnati, and other cities. The railroads that serve the Knobs make it possible for the Knob Belt to develop commercially and in every way, far more than it has up to the present time.

CHAPTER X

CLAY MINING AND THE CLAY INDUSTRIES

The Knob Belt contains enormous quantities of good, red burning Waverly shales such as the Rosewood of Jefferson County, the New Providence which outcrops on the slopes of the Knobs, and the Bedford formation of the northeastern portion of the Knobs. Residual clays from Knob limestones are in places used for brick. Alluvial clays are found along the Red and other rivers and are used to some extent. Clays situated near the Knob areas, but which are not derived as residual products from the Knob formations, are the alluvial deposits of

PLATE XLIV.
Waco Pottery, Waco, Madison County.

Pleistocene Age found along the Ohio River. Clays of the Irvine formation of the Tertiary occur in patches in Madison County, and are used for art pottery, stoneware, and other articles, Plate XLIV. In Rowan County to the east of the Knobs, southeast and northeast of Morehead are fire clay mines and plants, one fire clay strip extending into Carter County.

The clay products industry is located chiefly in Jefferson County, the majority of the plants being situated near Louisville. Clay pits in Jefferson County furnish a great deal of

raw material, but large quantities also are brought into the county from the fire clay deposits of eastern Kentucky and Indiana.

At Coral Ridge, Jefferson County, along the Louisville & Nashville Railroad, New Providence shale is excavated at the

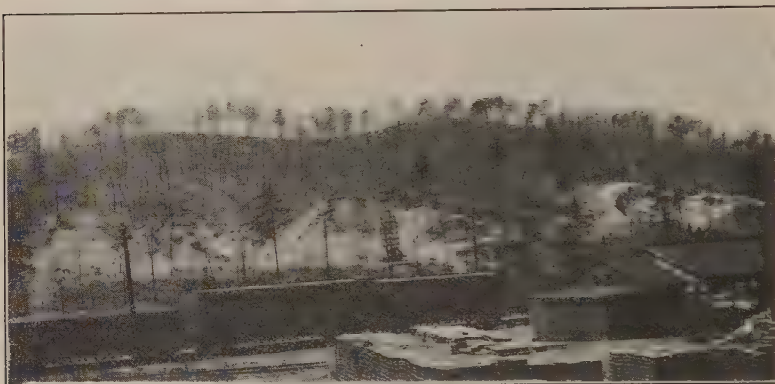

PLATE XLV.
Pit of the P. Bannon Pipe Company, Coral Ridge, Jefferson County. New Providence shale is being obtained from the knob.

pit of the P. Bannon Pipe Co., shown in Plate XLV. The shale was formerly quarried with an excavating machine, and taken by rail to the company's plants in Louisville. One plant makes common brick, hollow block and some fire brick. The fire clays come from Soldier, Carter County, Kentucky, and their No. 2 fire clay from Duff, Indiana. The other plant manufactures sewer pipe, flue linings and chimney tops.

The plant of the Coral Ridge Clay Products Company is situated about one-quarter mile south of Coral Ridge Station, Jefferson County, Kentucky, on the Louisville & Nashville Railroad.

The New Providence shale which is used, is secured from the company's pit 600 feet east of the plant. The base of a foot-hill to a higher knob that rises close by, is being worked at present with a steam shovel, Plate XLVI. There is no over-burden of any importance. Starting with the shale in the lower portion of the working face comes 12 to 15 feet of blue shale, above which lies 4 to 60 feet of brownish green shale,

depending on the location in the pit being measured. The face is about 400 feet long on the horizontal.

PLATE XLVI.

Pit of the Coral Ridge Clay Products Company, Coral Ridge, Jefferson County. The dipper is commencing to dig into the New Providence blue shale which is overlain by green shale of the same formation.

Analyses of the green and blue New Providence shales from the pit of the Coral Ridge Clay Products Company, Coral Ridge, Jefferson County, are given by Charles Butts, as follows: (Ref. 97:123).

	Green Shale	Blue Shale
Silica	60.44	60.40
Alumina	19.92	19.73
Ferric oxide	6.48	4.72
Lime	.28	.78
Magnesia	2.01	2.10
Potash	4.85	4.87
Soda	1.00	0.96
Phosphorus pentoxide	tr.	tr.
Sulphur trioxide	tr.	tr.
Titanic oxide	.80	.83
Ignition	5.20	5.96
Moisture	.79	.60
	101.77	100.95

The character of the green and blue shale at this pit is given by H. Ries, as follows (Ref. 97:126):

	Green Shale	Blue Shale
Plasticity	Very Good. Smooth	Very Good
Lime carbonate	None	None
Water of plasticity	27.7%	22.2%
Slaking time, minutes	28.	18.0
Average transverse strength, lbs., per sq. in.	289.0	241.0
Air shrinkage, linear	4.5%	3.5%
Color after firing	Red	Red
Steel hard	A little above 950° C.	950° C.
Soluble salts	Present	

Fire tests:

Temp.	Green Shale Fire Shrinkage %	Absorption %
950° C.	1.5	11.1
1070° C.	8.0	1.8
1150° C.	10.0	0.0
1170° C.	Overfired	

Temp.	Blue Shale Fire Shrinkage %	Absorption %
950° C.	1.	11.1
1050° C.	4.5	2.0
1070° C.	4.5	2.3
1150° C.	6.5	0.3
1190° C.	Overfired	

The clay is tempered in a pugmill and molded in a stiff-mud machine. There is also a hollow tile machine. There are five circular and five rectangular kilns, Plate XLVII. The

PLATE XLVII.
Plant of the Coral Ridge Clay Products Company, Jefferson County.

products made are hollow building tile, common brick and face-brick. They are shipped over the Louisville & Nashville Railroad to the nearby city of Louisville, where other railroads radiating in all directions serve to distribute the products to more distant markets.

Another deposit of New Providence shale, formerly used for brick, occurs six miles southwest of Louisville on the Illinois Central Railroad. In numerous other places in Jefferson County and throughout the Knobs, the New Providence shale offers an excellent and abundant supply of material for clay products plants.

Residual clay from the Jeffersonville limestone occurs over quite an area in Jefferson County. It is plastic, red burning, and the brick and drain tile which are made from it are excellent.

The Southern Brick and Tile Company has two plants with different pits, in the vicinity of Whitner, Jefferson County. The residual clay formed from the weathering of the Jeffersonville limestone is used. This clay is about ten feet deep. A section measured at one of the pits (Ref. 11:224) showed:

	Ft.
Earth, brown	1
Clay, tawny, stiff	2
Clay, red	4
Total	7

The brick clay has good plasticity, but is rather siliceous. Analysis of this Jeffersonville limestone clay from one of the pits here described is as follows (Ref. 11 opposite p. 236):

Silica	74.10
Alumina	10.38
Ferric oxide	4.48
Lime	.36
Magnesia	.85
Potash	1.72
Soda	.43
Manganous oxide	.32
Titanic oxide	1.00
Phosphorus pentoxide	tr.
Ignition (carbon dioxide combined water, etc.)=	4.20
Moisture	1.58
Total	99.42

In the pit the clay is loaded into cars and hauled up an incline to the plant where it is tempered in a pugmill and molded in a soft-mud machine. The fuel used in the kilns is producer gas. Common brick are manufactured at one plant, and drain tile at the other works.

The Progress Brick Company's plant is situated a short distance north of Camp Taylor south of Louisville. Residual clay from the Jeffersonville limestone is used. Common and front brick are made, the clay being molded in a dry-press machine.

The Louisville Firebrick Works has a plant at Highland Park south of Louisville on the Louisville & Nashville Railroad, and another plant at Grahn, Carter County. The Highland Park plant makes various grades of fire brick, locomotive blocks, rotary kiln brick, etc. The fire clays used come from this company's mines at Grahn, Carter County, and from Huntington, Indiana (Ref. 97:132).

The Louisville Pottery Company is located in Louisville and makes flower pots, stoneware, imitation whiteware. The flower pots (Ref. 97:131), are manufactured from the New Providence shale obtained at Bannon's pit, Coral Ridge. The stoneware is made from No. 2 fire clay of Huntington, Indiana. Sagger clay is secured from the Jackson Purchase Region of Kentucky.

Regarding shales suitable for paving brick, Charles Butts (Ref. 11:226) states: "It seems quite certain that at least the upper half of the Rosewood shale, Waverly formation, is suited for paving brick. Since there are limitless quantities of this shale easily available close to railroad lines, as along the Louisville, Henderson & St. Louis Railroad between Kathryn Station and the north side of Moremens Hill, it seems that the manufacture of paving brick might be undertaken with reasonable prospects of success and profit."

Madison County contains Tertiary clays of the Irvine formation, in the eastern part of the county, which are used in plants, located a short distance from pits, at Waco and Bybee. The Waco pottery manufacturers stoneware, crocks, bowls, and blue glazed art ware such as vases, etc. Some brick and drain

tile also are made. The stoneware is made from a mixture of Irvine clay with one-third sand.

The Bybee Pottery Company, Plate XLVIII, manufactures only hand-made blue art pottery which is sold in Kentucky

PLATE XLVIII.
Bybee Pottery, Bybee, Madison County.

and throughout the United States and Canada. This company is said to have been the first of the two plants to make blue, glazed stoneware.

A brick and tile plant formerly operated at Moberly, the raw material being ascribed to the Irvine formation, though there seems to be some doubt as to its exact geologic age.

At Lebanon, Marion County, is located the Goodwin Brick and Tile Company which made a good red, common brick and drain tile. A residual limestone clay is used.

In Nelson County the Nelson Brick and Tile Company have a plant at New Haven. Common brick and drain tile are made. A residual clay from weathered Ohio shale is used.

A common brick plant is operated by Atkinson and Baker about a mile and a quarter east of Stanton, Powell County, on

the Lexington & Eastern Branch of the Louisville & Nashville Railroad. The raw material is obtained from a pit in the alluvial clays of the Red River Valley. Beneath the alluvial clay comes five feet of shale, three feet of limstone, and then Ohio shale.

The successful location of a clay products plant necessitates, among other conditions, ample supply of good, uniform quality shale or clay without much, if any, overburden, which shale or clay can easily be mined, and is situated on a railroad. If possible the railroad should reach nearby large markets for the clay product. A small product of high value such as art pottery can be made at a greater distance from market than a heavier article which is cheaper per pound. Fuel should be plentiful and cheap. Labor, both common and skilled, should be obtainable at reasonable wages. Small brick and drainage tile plants might successfully supply the local demand, if they could put out a good product which would sell as cheaply or for even a less price than the larger companies at a greater distance could sell their products in the community.

The products manufactured from clay in Kentucky are numerous and include common and face brick, hollow blocks, flue linings, sewer pipe, drain tile, earthenware, stoneware, imitation whiteware, firebrick, flowerpots, art pottery, and other products.

The Knob Belt offers opportunities for further development of its vast, well situated deposits of excellent shale and clay, and for the erection of plants to manufacture clay products.

CHAPTER XI

CITIES AND MANUFACTURES

In the Knobs a cluster of small houses, a store or two and a blacksmith shop often occur at the intersection of the more frequented roads. These cross roads settlements supply goods of all kinds to the people of the surrounding districts. Where the roads are poor, the country stores occur at shorter intervals because the inhabitants cannot readily travel far to reach a store. The construction of improved roads in some localities has recently enabled the country people to go shopping easily greater distances than formerly. Larger stores, offering greater variety of merchandise in neighboring towns, have thus secured increased patronage. The change has brought about the abandonment of many small rural stores. Such stores as do continue in business usually have a gasoline station for motorists in addition to their general merchandise.

The small towns or villages of the Knobs are generally situated at the intersection of highways and enjoy a central location in a relatively small area, the size of which is dependent upon the condition of the roads. Railroads, as at Junction City, frequently aid in the industrial and commercial growth of the town.

Passes through the Knobs which connect the Bluegrass with the Mountains have determined or aided in the location of such towns and cities as Berea, Irvine, Richmond and others previously mentioned. The people of the nearby knobs and mountains drive to these towns to sell their farm products or exchange them for manufactured commodities. Mineral springs have aided the development of several of the Knob towns. Educational institutions which are situated in a number of the towns have added considerably to the local population and prosperity. Berea College, Berea, Madison County, is an example.

In the Knobs district county seats are often centrally located with respect to the entire county. There are, however, a few exceptions to this geographic location; such for example,

as Louisville and Vanceburg, which are situated on the edge of their respective counties. Usually the court house, with its surrounding square, forms the nucelus of the business section which has grown away from the court house. The accompany-

PLATE XLIX. COURT HOUSE, LA GRANGE, OLDHAM COUNTY.
On the front of this court house are recorded the names of the men from Oldham County who took part in the World War.

ing illustrations, Plates XLIX and LI, show the court houses of LaGrange, Oldham County, and of Lebanon, Marion County. The front wall of the LaGrange court house bears the names of all the men from Oldham County who went to the World War.

Vanceburg, Lewis County, is an example of a Knob town influenced in its development by the Ohio River. Until the construction of a railroad to Vanceburg, the town depended upon the Ohio River for its commercial communication with the outside world. Prof. Thomas Rowland, of Vanceburg, states that in the early days boats of all sorts passed back and forth between the river ports, and several boats stopped daily at Vanceburg. The boats carried the mail. They took on cargoes of tanbark and other products of the Knobs and Mountains and discharged merchandise to be sold in Vanceburg and the surrounding country. With the coming of the railroads the river traffic diminished. Several years ago, however, due to the influence of improvements in the Ohio River channel, river nav-

igation began to revive. At the present time, one boat from Pittsburg and one from Cincinnati stop at Vanceburg daily. These boats unload general merchandise and take on board agricultural and other local products. Barges loaded with coal from Pittsburg and other coal regions, also pass down the river to Cincinnati and other points. Occasionally a barge filled with coal is left at Vanceburg. The railroads here as elsewhere nowadays have secured the greater part of the freight and passenger traffic.

Theatre boats continue to stop at Vanceburg and give their performances. The show is given on the boat. A play with vaudeville between the acts is the usual program. Motion picture theatres at Vanceburg and other river ports are now regarded as formidable competitors to the old time theatre boat entertainments.

The special industries at Vanceburg are few in number. There is a button factory which manufactures buttons from mussel shells taken from the Ohio River. The buttons are cut in the rough and then are shipped to other cities to be polished and completely finished and made ready for use. A shoe factory is starting operations. The lumber trade handles sawed lumber, railroad ties and posts. A loose-leaf tobacco warehouse takes tobacco from Lewis and adjacent counties. Vanceburg has a high school, and the prospects are bright for increase in population and improved business conditions during the coming years.

Berea, Madison County, had a population in 1900 of 762. This increased by 1920 to 1,510. There are from 2,000 to 2,600 students in Berea College, and if this student body be added to the population of the town itself, the total number of inhabitants of Berea equals approximately 3,510. During nine months of the year, while the college is in session, the total population of Berea is within the city classification as regards numbers. The great majority of the students, however, are not residents of Berea and are not counted therein by the United States Census. The purchasing power of the students is considerable.

The principal streets of Berea are situated on a flat-topped ridge of Ohio shale, a remnant of the Lexington peneplain. Residential lots on the ridge are considered especially desirable because the ridge land has good air and water drainage and

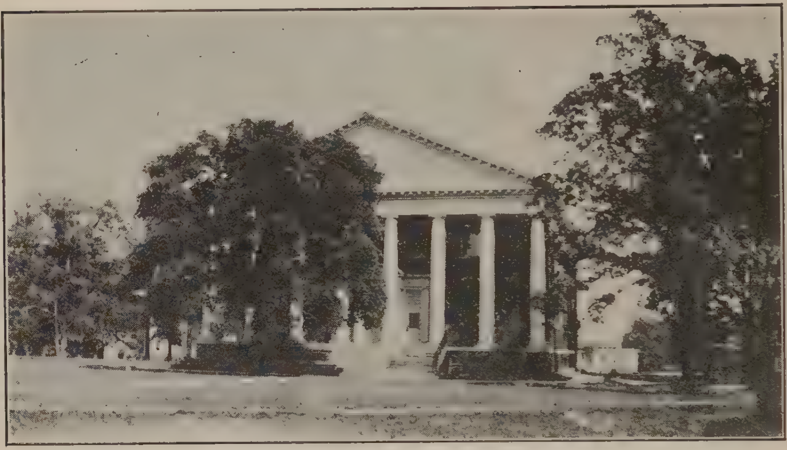

PLATE L. UNION CHURCH, BEREA.
The church is of red brick with limestone pillars.

excellent sidewalks and roads. The town activities such as the college, principal stores, banks, post office and churches, Plate L, are on top of the ridge. From certain ridge streets the view of the Knobs, Mountains and Bluegrass is very beautiful.

There are three business sections in Berea. One section is in the west end of town and extends on either side of the post office. The second section is nearer the east part of Berea, being located on the Dixie Highway facing the College Campus. The third section is at the west foot of the main ridge near the Louisville & Nashville Railroad. It is the smallest of the three business parts of the town.

The College is the chief center of life in Berea. But there are commercial industries, such as a grist mill, planing mill, and three or four weaving establishments where hand woven goods are made.

The streets and dwellings are lighted by electricity. There is an excellent system of water works. Roads are "piked"

and are kept in good condition. There are four churches in addition to the College Chapel. Berea has many fine homes and is a delightful place of residence.

The Knobs contain two cities, Irvine and Lebanon. Louisville is not a Knob city in the full sense of the word, though its suburbs extend into Knob territory. For this reason Louisville is only referred to as a market for the Knobs region. It has a position in Jefferson County somewhat similar to that of Vanceburg in Lewis County. Louisville grew up at the "Falls of the Ohio," where river transportation was obstructed by the rapids. A canal now leads around the rapids, but Louisville at present is not dependent upon the Ohio River, due to the many railroad lines that radiate from the city. Railroad transportion is the important factor in the development of this metropolis. Cities such as Winchester and Richmond are situated in counties containing the Knobs but are themselves not built on Knob formations. They are only treated by brief references.

Irvine, the county seat of Estill County, is built on a terrace on the north side of the Kentucky River which here cuts through the high knobs from the Mountains of Eastern Kentucky. A somewhat lower terrace on the south side of the river, Plate IV, stretches away to the high knobs mentioned, in the background.

The development of Irvine has been influenced by its strategic position at the entrance through the barrier of the westward facing escarpment of the Eastern Kentucky Mountains. From the early days of Kentucky to the present time goods have passed through this gateway into the mountains and the products of the mountains have come out of this pass to be distributed through the Kentucky lowlands and beyond. Irvine thus lies directly in the path of a commerce carried on between two distinct physiographic divisions of Kentucky, each having its own especial products which the other province needs. A toll-bridge spans the Kentucky River just west of Irvine. Over this bridge passes traffic between the east and west. A "piked" road connects Richmond and Irvine. This excellent highway will be extended into the Mountain counties.

Irvine was founded in 1812 and was named in honor of Col. William Irvine. In 1870 the town had a population of 224; in 1900, 260; in 1910, 272; in 1920, 2,705. The sudden increase in population was due to the discovery of the nearby Irvine Oil Pool.

The main business street of the older portion of Irvine extends away from the Kentucky River. One block northward from the river is the court house which stands back from the street surrounded by a lawn. Another principal business street extends eastward parallel to the Kentucky River and the Louisville & Nashville Railroad. This street connects the towns of Irvine and Ravenna which merge into each other. The street is macadamized.

The business prosperity of Irvine at present is due to the following factors: Irvine is a distributing center for nearby oil pools, and for the surrounding farming districts. The headquarters of the Eastern Kentucky Division of the Louisville & Nashville Railroad are spoken of as being at Irvine but the railroad shops are at Ravenna. The Noble & Hyden Lumber Company of West Irvine, formerly the Mowbray & Robinson Lumber Company, is situated just across the toll-bridge from Irvine. It manufactures and deals in rough lumber, switch ties, quarter-sawed white oak in the rough, lumber for flooring, furniture and the like. All kinds of hardwood are sawed at this mill and some soft woods such as pine for planks. Steamboats tow the logs down the Kentucky River to this and other mills. The Hazard Lumber & Supply Company of Irvine sells lumber wholesale and retail throughout the territory along the Kentucky River. Finished lumber and building supplies of all kinds are shipped by rail.

Coal in great quantities is shipped out of the mountains by rail and some is carried down the Kentucky River in barges towed by steamboats. Oil in tank cars, in oil barges, and through the Cumberland Pipe Line, passes out of Estill County.

Irvine has a high school, hotels, banks and other modern conveniences. When the oil fields are exhausted it will depend chiefly upon the railroad shops and the farming areas for its business activity. The erection of an oil shale plant near

Irvine is said to be contemplated. The Ohio black shale will be mined and distilled if this project is carried to completion.

Lebanon is the county seat of Marion County. This city in 1890 had a population of 2,816; in 1900, 3,043; in 1910, 3,077; and in 1920, 3,239.

PLATE LI.
Court House, Lebanon, Marion County.

In the earlier days of Kentucky Lebanon was the terminus of the Louisville & Nashville Railroad in this region, the railroad connecting this town with the city of Louisville. Lebanon then served as a distributing point for goods brought

in by rail. It supplied the counties of Marion, Taylor, Adair, Green, and other adjacent areas.

The industries in Lebanon at the present time are as follows: The S. H. Grinstead Company is a poultry fattening and packing house. The McCammon & Keller Company manufacture spokes and hubs. They obtain hickory and oak from the surrounding areas. A mill such as this one, usually remains in a region until the small trees are all cut, when it moves to another locality. If efficient forestry methods were practiced in the Knobs region, these sawmills, hub, spoke and other factories, could continue in the same locality for a much longer period than is now possible. The Lebanon Hardwood Flooring Company makes hardwood flooring, as the name implies. The Goodwin Brick & Tile Company has a plant on the south edge of Lebanon. Common brick and drain tile are made.

Lebanon also serves as a center for the surrounding farming areas. It has an up-to-date appearing business section which extends away from the court house on both sides of the street.

CHAPTER XII

POPULATION AND WEALTH

POPULATION

From early times the density of total population per square mile in the Knob counties increased until in 1900 it equaled 86.7; 1910, 93.3; 1920, 97.3, as against a State average in 1920 of 60.1. This greater density of population in the Knob counties as compared to the State average is due chiefly to cities in the Knob counties such as Louisville, Winchester, Richmond and other cities, none of which are in the Knob Belt proper. The Knobs contain only the two small cities of Irvine and Lebanon.

If incorporated places with a population of 2,500 or more are deducted, the density of the rural population per square mile in the Knob counties in 1900 is found to be 44.8 per square mile, 1910, 47.3; 1920, 47.1. The rural population increased until 1910, after which it declined slightly.

A comparison of the Knob counties as a whole and the rural districts of the Knobs shows that the total population of the Knob counties, including the cities, steadily increased up to 1920, the gain between 1910 and 1920 being 4. per square mile. At the same time the rural density decreased 0.2. Thus the rural population during this decade migrated to a small extent away from the farms doubtless to the cities. The density of total and of rural population in the Knob counties is given in Table No. 26 of the Appendix.

Analyses of the changes in urban and rural population are as follows: Urban population, as indicated above, includes incorporated places with a population of 2,500 or more. Under this classification, the Knob counties in 1910 included the cities of Louisville, Danville, Winchester, Richmond, Lebanon and Mt. Sterling; and in 1920 the additional cities of Oakdale and Highland Park, of Jefferson County, and Irvine, of Estill County. All of these cities increased in population from 1910 to 1920. Since the last Census Oakdale and Highland Park have become part of Louisville.

Changes in the rural population from 1910 to 1920, are the resultant of varying and sometimes conflicting factors in the Knob counties. The decrease in rural population, in the counties in which it occurred, and the increase of migration from the country to the city are affected by: (1) Net decrease of improved land. This is caused chiefly by too long continued cropping of the soil without adding adequate fertilizer or humus; and soil erosion; both causing a lower income from the farms, other things being equal.

(2). Isolation of the farms due to bad roads, distance between farms, and distance between farms and nearest towns, cause the attractions of the city to stand forth with all the more glamor.

(3). Farm labor is hard and monotonous, especially in the rugged regions where labor saving machinery often is impracticable on account of the roughness of the topography; and the hours of work on the farm are long compared to those in the city.

(4). Farm wages are low in comparison with those usually received in the city.

(5). The farmer's income is variable due to uncertainty of crops and other sources of farm income such as live stock, and fluctuations in the selling prices of agricultural products; whereas the workingman in the city knows quite definitely what he will receive for his labor.

(6). If the farmer invests his own or borrowed money in his crops or live stock, he runs the risk of losing his principal as well as interest in the money invested, and also his labor. Even if ordinarily successful, the farm income too often is not equal to what the farmer could secure if he put his money in some sound interest bearing investment and worked in the city. He thus is losing money by staying on the farm, and consequently moves to the city.

Some of the detrimental features of farm life are coming to be partially remedied. The U. S. Rural Mail Delivery is putting the farmer in contact with the outside world. The farm houses, here and there, are being improved with more modern conveniences and some little luxuries such as the phon-

ograph and other musical instruments. It will not be long before radio receiving sets are installed in more of the homes. Telephones and automobiles also are bridging the distance between the farms, and farms and town. Good roads and scientific farm management, should help to solve the problem of keeping the young people upon the farms. Continued loss of many of the more progressive of the younger generation from the farms, small as it has been in the Knobs during the 1910 and 1920 decade, will eventually have a serious effect upon the prosperity of the State.

The population of the rural areas of the Knobs is nearly entirely white. In the pioneering period, the settlers were Scotch-Irish, Irish, and English; and the names of the present day inhabitants of the Knobs bear evidence of their direct descent from these daring men and women of long ago. A stranger in the Knobs and Mountains of Kentucky always is impressed with the clean cut entirely American and English type of face that he sees; for these regions, due to the isolation which they enjoyed up to the last few years, still contain a people with a purity of true American blood found nowhere else outside of the Appalachian Highlands.

The settlers came from Virginia, North and South Carolina, and from Maryland, Pennsylvania, and other States. Primarily Southern, they brought to Kentucky many of the characteristics of the Southern States. Large plantations worked by slave labor developed the aristocratic society of the Old South in the more level Knob and Bluegrass areas. In the rugged Knobs and Mountain districts small farms grew up, for due to the roughness of the topography the farmer worked his own land. The difficulty of making a living engendered a spirit more akin to that of the woodsmen of early New England. This influence of the physiography of Kentucky, determined that in politics the rugged Knobs and Mountains should in general be Republican while the Bluegrass areas went Democratic. Of course there are many exceptions.

Statistics, Table 27, show that the knob counties in 1910 had a total population of 80.3 per cent native white, 4 per cent foreign born white, and 15.5 per cent negro. In 1920, there were

83.7 per cent native white, 2.7 per cent foreign born white, 13.4 per cent negro. The State averages in 1910 and 1920 were native white 86.8 per cent and 89 per cent; 1.7 per cent, 1.3 per cent foreign born white; 11.4 per cent, 9.8 per cent negro. The higher per cent of foreign born white and colored in the Knob counties compared to the State averages is due to Louisville being situated in the Knob county of Jefferson. Jefferson County in 1920 had 4.8 per cent of its population foreign born, and 15.5 per cent colored. Louisville contained 84 per cent of all the foreign born population in Jefferson County, and 90 per cent of the negroes.

The native white are thus seen to be increasing in per cent in the Knob counties; the foreign born white are decreasing and if the present rate of decrease continues will have entirely disappeared within a comparatively short time unless augmented in numbers by immigration or an increased birth rate. The colored race, which is next in numbers to the whites, diminished in per cent in the Knob counties from 15.5 in 1910 to 13.4 per cent in 1920.

The distribution of native and foreign born white and negroes by counties as influenced by the geographic environment is as follows: The largest foreign born white population is in Jefferson County, the vast majority living in Louisville. Of the total population of Jefferson County, 7.3 per cent in 1910 and 4.8 per cent in 1920 consisted of foreign born white. On the other hand the mountainous Knob counties have a small and also decreasing foreign born population. In 1910 Powell and Estill counties, Plate LII, each contained only three foreign born white, which was less than one-tenth of one per cent of the population of each of these counties. By 1920 the foreign born white population in Powell had diminished to one individual, but Estill's increased to thirteen individuals, for during this decade occurred Estill's oil boom. In the other more remote Knob counties the foreign born white population is extremely small.

The negro population, as already described, is concentrated chiefly in the cities, especially Louisville. The more level Knob counties with a well developed tenant system, contain a higher

per cent of negro population than occurs in the more rugged counties. Thus Madison County in 1920 had 4,910 or 18.7 per cent of its population negro. There were 481 negro farmers, of whom 296 were owners operating farms, and 183 were tenants.

PLATE LII. VALLEY OF COW CREEK, ESTILL COUNTY.
Looking northeast toward the Irvine Oil Pool. Knob topography shown.

Compare these statistics with those for Rockcastle County, a more rugged area, where there were 70 negroes, or 0.5 per cent colored in the total population. Of these colored folk only seven were farmers, of whom five were owners operating farms and two were tenants.

The negro population has always been distributed as described above, namely, smallest in the more mountainous districts and largest in the more level areas. In 1860, for example, Madison County contained 6,182 negroes, and Rockcastle only 397; Rowan, 143; Powell, 149.

The negro race in the Knob counties is decreasing for the following reasons: (1). The negroes have left the South, including Kentucky, in great numbers for the industrial centers of the Northern States, where they obtain labor; (2) The small farmers in the rugged Knob districts do not employ negro labor, and only on the larger plantations of the more fertile, level areas does he find a farm system in which he can be of service. He has therfore drifted to the city; or more rarely, settled on a small farm of his own. In the rural districts consequently the negro is becoming less and less a factor. In the cities, he doubtless will continue to exist, as employment is there obtainable to

meet his needs. As far as the Knobs are concerned, the problem of the negro's future is being settled by the powerful forces of geographic environment.

Wealth

Jefferson County ranked first in 1920 among the Knob counties with a total taxable wealth of $420,255,047 and a taxable wealth per square mile of $1,085,930. This great wealth is due largely to the city of Louisville. Boyle County ranked second with $19,576,796 of total taxable wealth, and $105,251 of taxable wealth per square mile. Clark County came third with a total taxable wealth of $26,715,966 and a taxable wealth per square mile of $100.814. The total taxable wealth for the Knob counties as a whole was $619,325,213 and the taxable wealth per square mile was $114,604. A comparison of the per capita taxable wealth of the Knob counties shows that Clark County ranked first in 1920 with $1,492.42 taxable wealth per capita; Jefferson, second, with $1,467.52; Boyle third, with $1,305.29. The Knob counties as a whole had a taxable wealth of $1,177.14 per capita.

The influence of geology and physiography upon the wealth of each of the Knob counties is vividly shown as follows: Counties having large areas of the more level Knob and Bluegrass territory, with rich limestone soils, rank highest in total per square mile and per capita taxable wealth. The wealth of Boyle and Clark counties which ranked first and second, if Jefferson County be excluded on account of Louisville, already has been noted. Other instances of rather level, rich-soiled Knob counties are Montgomery County with a wealth of $73,586 per square mile and $1,189.88 per capita; and Garrard County with a taxable wealth per square mile of $62,304 and $1,181.00 per capita. On the other hand, the more hilly Knob counties have a lower assessed valuation. Estill County had a taxable wealth of $18,600 per square mile, $303.46 per capita; Powell County $12,195 per square mile and $327.25 per capita; Rockcastle County, $10,510 per square mile and $211.48 per capita. Table 28 shows the same relationship between physiography and wealth to hold true for the balance of the Knob

counties. The poorer, hilly, rougher-surfaced Knob counties can increase their wealth by proper agricultural and forestry methods and development of the mineral resources.

SUMMARY AND CONCLUSION

The Knob Belt has been described in detail in the preceding chapters. The main facts discussed and the various relationships between the geographic control and the life responses will now be summed up briefly.

The Kentucky Knobs are a belt of conical and flat topped hills and "mountains" with a narrow strip of rolling land forming their inner margin, which extends in the form of a horseshoe from near Vanceburg, on the Ohio River, in Lewis County, to the northern portion of Oldham County; a distance of 233 miles. The Knobs pass through portions of the counties of Lewis, Fleming, Rowan, Bath, Montgomery, Clark, Powell Estill, Madison, Rockcastle, Garrard, Lincoln, Boyle, Marion, Nelson, Bullitt, Jefferson, and Oldham. Within the horseshoe formed by the Knobs lies the Bluegrass. Outside the curve on the east and southeast the Knobs merge into the Mountains. On the northeast, south and west they pass into the Mississippian Plateau. Along the northern ends Quaternary and Recent deposits form a narrow strip between the Knobs and the Ohio River.

The strata forming the Knob Belt extend in age from the base of the Silurian into the Mississippian and in some places into the Pottsville of the Pennsylvanian System.

The principal rivers are the Ohio River, which flows past the northern extremities of the Knobs, the Licking, Red, Kentucky, Dix, Rolling Fork and Salt rivers.

Numerous smaller streams also are eroding the Knob areas. The gradient of most of the streams is so steep that sudden fluctuations in the volume of the creeks occur after heavy rains or melting snow. The rapid run-off increases soil erosion, thereby ruining large areas of Knob land which under correct farm management could have been made to pay a net income.

The valleys and river divides have controlled the location of the wagon roads and trails. Rivers serve as boundaries between many of the Knob counties; and the Ohio River divides

Kentucky from Ohio, Indiana and Illinois. Commerce is carried on upon the Ohio and Kentucky rivers. The gaps through the Knobs which have been cut out by rivers, serve as gateways connecting the Mountains and Plateau with the Bluegrass and other regions. Railroad lines extend through the gaps.

The Knobs have a humid, temperate, continental type of climate. The prevailing annual winds are from the southwest except during a few months in certain sections. Little rain falls during the Autumn months. In winter the ground is not frozen deeply and thaws quickly. This results in a greater amount of soil erosion than would occur in the northern States under similar physiographic conditions. Snow remains on the ground only a few days. The Knobs as a whole have a mean annual temperature of 55.7 degrees. The annual minimum and maximum means are 44.0 and 67.5 degrees respectively. Killing frosts in the spring cause damage chiefly to fruits. Fall frosts damage corn and tobacco. The climate, however, permits of the growing of a variety of crops.

The Knob soils taken as a whole are naturally poor and thin. They can, however, be built up to produce good crops. Over most of the area residual soils occur. Those derived from the Ohio shale are considered especially poor for agricultural purposes. Fruit growing on the limestone soils of the tops of some of the knobs, is an industry that has yielded good returns.

The soil erosion is rapid on the steep, bare slopes of the knobs. Unless the land is forested, cover crops should be planted when the land is not in cultivation. Correct rotation of crops, addition of humus, lime, Plate LIII, phosphate, drainage and correct farm practice will usually cause the Knob soils to yield adequately.

The Knobs contain enormous quantities of excellent shale and clay suitable for the manufacture of brick, hollow-tile, sewer pipe, and other clay products. Smaller deposits of pottery clay are also found. The clay products industries are important especially near Louisville. Almost limitless amounts of shale, favorably situated as to transportation and markets, remain as potential sources of wealth for future generations.

Sand and gravel are obtained from the rivers and from weathered Pottsville conglomerate outcrops. The glass sand district of Carter County extends into Rowan County. Bordering the Knobs along the Ohio River on either side of Louis-

PLATE LIII. LIMESTONE CRUSHER.
Agricultural lime is of great benefit to the Knob soil. Photo by Robt. Spence.

ville, occurs a good building sand. After washing and screening, it doubtless could also be used as a glass sand.

Sandstone and limestone formations occur which are suitable for the construction of buildings and for sills, columns, interior decoration, foundations, abutments, culverts, road metal, railroad ballast, lime, natural cement, Portland cement, agricultural lime and many other purposes. Numerous quarries are in operation but great reserves of stone, favorably situated as to transportation and markets, yet remain untouched.

Coal occurs in small quantities in limited areas near the tops of the highest knobs.

Oil has been found in large quantities. It is obtained chiefly from the Onondaga limestone. Oil doubtless still exists in economic quantities in areas as yet untouched by the drill.

Oil shale occurs in great quantities throughout the entire Knob belt. In the comparatively near future this shale will probably be of great value as a source of petroleum and numerous other products.

In former days iron ore was successfully mined in a few Knob counties. At present this iron ore is too low grade to compete economically with the high grade ores of other States. When the ores which have a high metallic iron content are exhausted, the Kentucky iron ores again will become of value.

Springs are found in many places. Wells of water can be obtained at a depth usually less than fifty feet. Care should be taken to investigate before using spring or well water for it may have become contaminated and contain typhoid germs.

Important mineral springs of sulphur, chalybeate, salt and other waters are found. Large quantities of pure spring water are shipped to the nearby cities for table use.

Salt has been obtained in the Knobs from the saline springs and wells since early pioneer days.

PLATE LIV. FORESTED SLOPES IN THE ROUGHER KNOBS.
Scene in southeastern Madison County, looking north.

The native forests have to some extent been protected by the rugged topography. The rougher surfaced Knob areas, Plate LIV, still have a higher per cent of forests per square mile than occurs in the more level areas. The sawmills which cut the logs into smaller sizes or rough lumber are located in the Knobs and Mountains. Logs are still floated down the Kentucky River to mills at Irvine and farther downstream, but large amounts of rough lumber and logs are carried by rail to sawmills and planing mills near the cities as it has been

found that transportation by rail has many advantages over transportation by water, especially since locks have been constructed in the Kentucky River. The planing mills usually are located near the larger cities of the Bluegrass which furnish markets for their finished products.

In the Knobs the larger trees have been mostly cut and even smaller hard woods such as oak and hickory are being taken to be made into spokes, hubs, baseball bats and other articles. Railroad ties are shipped out of the Knobs and Mountains. The deforested areas are being completely ruined by soil erosion or are becoming covered by a second growth of less commercial value than originally clothed the slopes. At the present rate of decrease the woodland in the Knobs will have vanished by 2047 A. D. Correct forestry methods should be practiced and the lumber industry revived. The steeper slopes especially should be forested to prevent erosion. Quick growing trees should be planted to be cut and sold for posts. Trees that yield a nut crop such as walnuts and hickory nuts, should be planted in favorable locations on the knob slopes. The nuts when gathered and sold should return the farmer an income from land that at present is practically worthless. The vanishing of the forests is even reflected in the greater number of wooden fences and log cabins that are seen in the rougher surfaced forested areas as compared with the more level regions were the trees have been almost entirely cut away.

The wild animal life consists of birds, snakes, rabbits, squirrels, woodchucks, chipmunks, skunks, muskrats, opossums, racoons, gray and red foxes, and wildcats. The streams that flow into the larger rivers afford good fishing, particularly near their mouths. Some ponds are stocked with fish.

Knob counties containing more level or rolling land in proportion to their total land area have a lower percentage of unimproved land than is found in the counties having a higher per cent of rough knob and mountain area. During the decade of 1910-1920, the smallest changes in the per cent of unimproved and improved land occurred in the counties containing the greatest areas of level Knob and Bluegrass land. The unimproved land, exclusive of woodland, includes large areas ruined

by overcropping and erosion. Proper farming methods should be used to prevent such needless loss of property.

The greater the area of rich, level land on each individual farm, the more every acre on the farm is improved. There was, however, a slight decrease in the area of improved land in the Knobs during 1910 to 1920.

PLATE LV. KNOB TERRITORY RECLAIMED BY DRAINAGE.

One and one-half mies northwest of South Park Station, Jefferson County, looking southward. The flat land was once a swamp. In the field just beyond the sheep is the side of a drainage ditch. The knobs of southwestern Jefferson County are seen in the distance.

Drainage of swamp land is not a problem in the Knobs as a whole, because of the rapid fall of the streams. An extensive swamp, however, has been drained in the vicinity of South Park, Jefferson County, Plate LV, and the reclaimed land is now being farmed. Tile and other forms of drainage, especially on the shale soils, will increase the crop yield.

The total number of farms in the Knob counties increased 16.42 per cent from 1900 to 1910; and 1.34 per cent from 1910 to 1920. At the same time the average farm was becoming smaller by sub-division. In the counties having large areas of rich limestone soil, it was possible to reduce the size of the farm without unduly reducing the standard of living to the extent it might have been lowered if the county had been entirely rough knob or Ohio shale topography. Cultivation of tobacco often enabled the farmer to make a living from fewer acres of land than otherwise might have been possible.

The per cent of increase in land values bears a direct relation in most of the Knob counties to the increase in the number of farms. Discoveries of oil in Estill County had a greater influence, however, upon the increase in value of farm land than did the additional number of farms formed in that county.

The topography also greatly influences the value of the land. Rugged counties with their poorer soils and more difficulties in farming and in reaching a market, have lower land values, other things being equal, than the more level Knob counties.

The per cent of increase in valuation bears a direct relation to the amount of improved land per farm. In the more rugged counties the per cent of increase in valuation from 1910 to 1920 was large, but the actual increase in valuation was a fewer number of dollars per acre and there was a smaller number of improved acres per farm than in the more level Knob counties. Of course, the greater acreage of improved land per farm usually was dependent upon the fertility of the soil and the ease with which the land could be cultivated, so that the increase in valuation per acre was determined fundamentally by the geographic conditions.

The per cent of increase in land values has been greatest, with few exceptions, where tobacco is grown extensively. This is because the value of an acre of land is dependent largely upon the net earnings which can be secured from it.

The increase in price of all farm products a few years ago, also caused an increase in the value of farm land. The decline in the price of farm products which followed the period of prosperity resulted in a sharp decline of land values. The more mountainous counties which did not raise so much tobacco, and other crops that had a severe fall in price, did not have their land values decrease as much as the richer, more level areas where tobacco and these other crops were raised so extensively.

The assessed value of all property per farm bears a relation to the size of the improved acreage and to the topography. The assessed valuation and also the improved acreage are greater in the more level areas than in the hilly sections. The fertility

of the soil should be taken into account as determining to a great extent the amount of improved, cultivable land.

The farm incomes from the gross crop returns are larger in the richer, more level Knobs than in the hilly districts.

The principal crop grown in the Knobs is corn. Other cereals raised are oats, wheat, rye, and barley. Irish potatoes are produced in large quantities, especially near Louisville, where two crops of potatoes are raised during the same year. The nearness to transportation lines and to large markets is an important factor in locating the potato industry in Jefferson County.

Sorghum is raised in greater amounts in the more remote and inaccessible areas where all of the necessities of life are produced as far as possible on the farm.

Tobacco is the chief cash crop on many of the Knob farms. It is produced only with much intensive labor. But it furnishes quite steady employment throughout the year. If the patch of tobacco is large and the farmer does not hire outside help, the work is performed by the entire family. Tobacco, however exhausts the soil rapidly, leaving the land in poor condition. Unless the soil is cared for properly, erosion completes the ruin of the field. Farmers who depend almost entirely upon their tobacco patch for their ready money are unwise, as unfavorable climatic conditions may cause a loss. It is safer to diversify the kind of crops grown. The average yield of tobacco per acre in the Knob counties and in the State as a whole, is decreasing.

The price of tobacco, as already mentioned, had an important influence upon the acreage planted and on land values. The increase in the net profit per acre of tobacco raised was accompanied by an increase in the value of tobacco land. When the price fell in 1920, farmers and others who had over-extended themselves financially in purchasing farms were ruined.

Truck garden crops and small fruits are raised most extensively near Louisville which furnishes a large market. Market gardening can be developed successfully near smaller cities and towns.

The production of more small fruits for home use in the Knobs region will add to its health and wealth generally.

Orchard fruits are grown quite widely throughout the Knobs. The climate is suitable, except for frosts which sometimes occur with damaging effect. Orchards should be located on hilly knob land which gives good air drainage, and at least partial protection from the frosts. Modern methods of cultivation and frost protection will increase the revenue from these sources.

The animal industries are increasing in the Knobs. This is of benefit to the soil, and should increase the prosperity of the Knob counties.

There are more horses in the Knob counties which have wider areas of level and rolling land than in the Knob counties which have a rougher topography. Horses have decreased in all of the Knob counties, except Rockcastle County, during the last decade. This decrease in the number of horses was caused by the increase in the number of automobiles, better roads, tractors, and by mules displacing horses. Mules can do heavier work than horses, and are considered by some to be surer footed than horses, on the steep, rough knob and mountain slopes. Mules increased from 1910 to 1920, the increase being greater in the hilly Knob counties than in the more level counties.

Dairy and beef cattle are found in greater numbers in the counties containing larger areas of level or rolling land than in the more rugged districts. More beef cattle are fattened on the richer, more level limestone soils than in the rougher surfaced districts. Dairy cattle are kept especially for the sale of whole milk near the large cities. Butter, cream, and cheese can be produced from milk at considerable distance from market because these products are of a rather high value per pound and hence can be economically shipped farther than can whole milk.

The number of cattle in the level portions of the Knob counties decreased from 1910 to 1920, while the number of cattle in the hilly counties increased. But even then the number of cattle in the more level counties remained greater than in the hilly counties.

The level counties which had the greater number of cattle also raised more hay and forage per square mile in 1919 than was grown in the hilly districts.

The sheep industry is often associated with hilly land which is not readily cultivated. Large areas of Knob land are therefore suitable for the raising of sheep. But at present, more sheep are kept on the richer, level lands than in the hilly sections. This lack of development of the sheep industry in the more rugged areas is because of the damage done to the sheep by dogs, unless the sheep are carefully fenced in and guarded.

Goats should do well on the Knob slopes.

Swine are raised and fattened in far greater numbers in the richer, level Knobs than in the more hilly counties. On the average the counties containing the largest number of swine also produce heavy yields of corn per square mile. The raising and fattening of swine is increasing in the Knob counties. Care should be taken to inoculate the swine against hog cholera.

Poultry and bees are profitable in the Knobs. Poultry is increasing. The hilly counties have increased their production of honey greatly since 1909. Poultry products and honey are articles of high value per pound that can be brought to market over rough roads and shipped economically long distances. Poultry and bees should be carefully cared for if the best results are to be obtained. To aid the bees in their work, sweet clover should be planted. The clover will also increase the fertility of the soil.

The Knobs contain evidences of the Mound Builders having inhabited the region during prehistoric times. Madison County contains the largest forts made by these people in the Knobs, Plate LVI.

The topography of Kentucky determined the location of the Indian trails and buffalo traces. Later these paths became the white man's trails which developed into wagon roads. Some of the trails now have railroad lines laid along their courses.

The rural population of the present day came from Scotch-Irish, Irish and English settlers of pioneer times. The names

of the inhabitants bear evidence of their direct descent from these early settlers.

Living conditions, especially on the Ohio shale soils, are difficult for the farmer of small means. The limestone soils usually have more prosperous farmers. A greater number of

PLATE LVI. A PREHISTORIC STRONGHOLD.
The south side of "Basin Mountain" here shown is about 1,600 feet in length, measured in a straight line. The break in the cliffs is guarded by a stone barricade.

tractors are used on the farms of the more level Knob counties than in the rougher surfaced counties. Weaving and basket-making are industries that can be developed in the home.

Better roads will greatly improve farm life and increase farm income and farm values. As it is, the inexpensive, light weight automobile has brought the country people into closer union with the towns. The U. S. Mail Service has extended its Rural Free Delivery into the Knobs. This has brought the people into closer contact, especially through the daily newspaper, with the outside world. The radio is bringing enjoyment to many homes.

Illiteracy exists in all of the Knob counties. The rugged counties contain a higher per cent of illiteracy than the more level counties. Illiteracy, however, decreased during the last decade.

The rural schools are a fundamental factor in the educational development of the Knobs. They should be aided in every way. Roads should be improved so that the children can attend school even in bad weather.

Reading circles are being developed under the auspices of local libraries. In this way the older members of the rural community find quiet recreation and general education.

High schools, academies, normal schools and colleges are located in many of the Knob towns.

Health conditions can be greatly improved. The death rates from tuberculosis and pneumonia are greatest in the Bluegrass with the Knobs second and the Mountains third. A breeding place for germs in the Knobs is the ill-lighted, poorly ventilated and often over-crowded one room dwelling.

Typhoid fever is more prevalent in the Knobs than in the Bluegrass or Mountains. The reason may be that in the Knobs the houses are clustered closer together in parts of the rural districts and in some of the small towns than usually occurs in the Mountains. Lack of fly-screened toilets aids the spread of typhoid and should be remedied. Contaminated springs, wells and drinking utensils also spread typhoid fever. The better sanitary conditions and water supplies of the Bluegrass cause a lower death rate in that physiographic division.

Hookworm and trachoma occur and cause much suffering. Hookworm may be easily cured. Trachoma may be avoided by not using a common washbasin, soap or towel. In the early stages it can be cured by an operation upon the eyelids.

The more hilly counties with their low average value per acre, do not have nearly so high a percentage of tenants on the farms, as do the counties containing large areas of more level land of much greater value per acre. The reasons for this difference of tenancy have already been given in detail. Jefferson County, however, has a rather small per cent of tenancy even though the average land value is high. This is due to the nearness to Louisville and the intensive farming that is practiced in this county where numerous owners care for their own truck farms. Tenancy has increased 30.2 per cent in the Knob counties during the last twenty years. This increase in tenancy has been chiefly in counties containing rich, level soils. The few tenants in the hilly counties are usually white. Tenancy in the mountainous Knob districts will never be a problem as the physiographic environment prevents its development.

Native white farmers are increasing in numbers in the Knobs. Foreign-born white farmers, negroes and other non-whites are decreasing. In the mountainous Knob counties nearly all the farmers are native white. The greatest number of foreign-born white occurs in Jefferson County where truck gardening is carried on and with Louisville as its center. Negroes have always been rather few in number in the mountain area. They are found in far larger numbers in the level counties where the plantation type of agriculture was practiced in pre-Civil War Days. The negro population is concentrated chiefly in the cities, especially Louisville. Within the last few years the negroes have left the South, including Kentucky, in great numbers for the industrial centers of the Northern States. In the Knob cities the negro will doubtless continue to exist, as employment is there obtainable; but in the rural districts the negro is becoming less a factor, due to the influence of geographic environment.

"Piked" roads are being made across certain Knob districts, greatly to the benefit of the country through which they pass. Several main highways for automobiles traverse portions of the Knobs. The roads should be improved continually throughout all of the Knob Belt.

Railroads reach most of the Knob territory. Thus the farmer has to drive only a few miles to the nearest railway station in order to ship his products to the larger city markets. Railroads have absorbed the major portion of the river traffic in the districts where they parallel navigable streams.

Clay mining and the clay products industries are important in the Knobs.

The Knob Belt contains the cities of Irvine and Lebanon. Irvine owes its rapid growth to the discovery of oil pools in Estill County. Railroad shops are now located near this city. Part of Louisville is built on Knob strata. Other cities in the Knob counties are outside the Knob Belt proper. The cities and towns of the Knobs as a whole are progressive and improving in many ways.

The destiny of population in counties which contain the Knob Belt was 97.3 per square mile in 1920, as against a State

average of 60.1 in the same year. This greater density of population in the Knob counties is due to cities such as Louisville, Winchester and other large towns which are mostly outside the Knob Belt proper.

The rural population to a small extent has moved away from the farms to the cities during the last decade. The causes for this decline have been discussed in detail. Continued loss of many of the more progressive of the younger generation from the farms will eventually have a serious effect upon the prosperity of the State.

In 1920, Jefferson County ranked first in taxable wealth among the Knob counties, having an assessed valuation of $1,085,930 per square mile. This great wealth was due largely to the city of Louisville. Knob counties having larger areas of level land with richer, limestone soils, rank highest in total taxable wealth both per square mile and per capita. The hilly Knob counties have a lower assessed valuation. The poorer, rougher counties, however, can increase their wealth.

In conclusion it should be remembered that great as has been the development of the Knobs up to the present time, enormous undeveloped natural resources yet remain in the form of clay, shale, building stone and rock for other purposes, oil shale, oil, gas, mineral water, and farm land that will yield well under scientific development and management. The steep slopes await modern forestry methods. Sheep and other live stock can be increased. Poultry and bees will add to the farm income. Fruit growing can be developed still further. Near the cities truck gardening can be carried on. Good roads will aid in every way. If the potential possibilities in the Knobs are developed, an increasing revenue will result not only to the individual citizen but also to the county and State.

Table 1

ASTRONOMICAL STATIONS IN THE KENTUCKY KNOB COUNTIES.

(Ref. Hoeing, J. B., Ky. Geol. Surv., Ser. IV., Vol. I, Pt. 2, 1913.)

Place	County	Latitude			Longitude		
Anchorage	Jefferson	38°	15′	47.4″	85°	32′	19.2″
Avoca	Jefferson	38	15	22.1	85	30	01.0
Brownsboro	Oldham	38	21	27.9	85	30	00.4
Cox Knob	Jefferson	38	09	25.4	85	46	15.8
Highland Park	Jefferson	38	11	15.2	85	45	24.0
Huber	Bullitt	38	01	59.7	85	42	34.2
Lakeland	Jefferson	38	16	10.8	85	33	16.2
Longrun	Jefferson	38	13	48.0	85	25	30.0
Louisville	Jefferson	38	15	31.6	85	45	54.77
Middletown	Jefferson	38	14	41.9	85	32	23.1
O'Bannon	Jefferson	38	17	18.8	85	30	48.0
Pewee Valley	Oldham	38	18	31.8	85	29	22.1
Richmond	Madison	37	44	39.6	84	17	51.2
Shepherdsville	Bullitt	37	59	16.6	85	42	59.9
Smithville	Bullitt	38	00	46.2	85	30	52.4
St. Matthews	Jefferson	38	15	10.2	85	39	37.0
Westport	Oldham	38	28	46.46	85	28	25.93
Whitfield	Bullitt	38	05	35.5	85	28	31.8

TABLE 2

ELEVATIONS ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES

Compiled from Cooperative Work of the Kentucky Geological Survey and United States Geological Survey and from the Various Railroad and River Surveys.

(Ref. Hoeing, J. B., Ky. Geol. Surv., Ser. IV, Vol. I, Pt. 2, pp. 1213-1216, 1913.)

Place	County	Station	Elevation
Alms House	Jefferson	I. C. R. R.	464
Anchorage	Jefferson	U. S. B. M.	724
Argyle	Powell	L. & E. Station	722
Bardstown	Nelson	L. & N. R. R.	637
Bardstown Jct.	Bullitt	L. & N. R. R.	417
Beard's	Oldham	L. & N. R. R.	761
Beckley	Jefferson	U. S. B. M. L. & N. Station	599
Bell's Mill Ford	Bullitt	U. S. B. M.	423
Belmont	Bullitt	L. & N. R. R.	431
Berea	Madison	L. & N. R. R.	943
Bethany	Jefferson	U. S. B. M.	452
Big Spring	Bullitt	L. & N. R. R.	514
Bishop	Jefferson	L. S. R. R.	459
Bloomfield	Nelson	U. S. B. M.	669
Bloomfield	Nelson	L & N. R. R.	595
Boonesboro	Clark	L. W. in Kentucky River	538
Boone's Gap	Madison	L. & N. R. R.	1,130
Boston	Jefferson	U. S. B. M.	615
Boston	Nelson	L. & N. R. R.	431
Bourne	Garrard	U. S. B. M.	928
Broadhead	Rockcastle	L. & N. R. R.	903

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Brooks	Bullitt	L. & N. R. R.	490
Brownsboro	Oldham	L. & N. R. R.	770
Brumfield	Boyle	L. & N. R. R.	1,014
Brush Creek	Rockcastle	L. & N. R. R.	924
Bryan	Jefferson	U. S. B. M.	659
Buckner	Oldham	L. & N. R. R.	792
Buechel	Jefferson	U. S. B. M.	500
Buena Vista	Lewis	C. & O. R. R.	523
Calvary	Marion	L. & N. R. R.	609
Camp Dick Robinson	Garrard	U. S. B. M.	915
Campton Jct.	Powell	U. S. B. M. L. & E. Station	747
Cane Spring	Bullitt	L. & N. R. R.	623
Carrs	Lewis	C. & O. R. R.	532
Clark	Jefferson	L. S. R. R.	674
Clay City	Powell	U. S. B. M. L. & E. Station	628
Colby	Clark	C. & O. R. R.	1,023
Concord	Lewis	C. & O. R. R.	518
Conway	Rockcastle	L. & N. R. R.	951
Coral Ridge	Jefferson	U. S. B. M.	500
Cowan	Fleming	L. & N. R. R.	927
Crab Orchard	Lincoln	L. & N. R. R.	919
Crescent Hill	Jefferson	L. & N. R. R.	515
Danville	Boyle	Q. & C. R. R.	955
Danville C. H.	Boyle	U. S. B. M.	989
Deep Cut	Carter-Lewis	C. & O. R. R.	1,036
Dravo	Jefferson	L. S. R. R.	599
Duncannon	Madison	L. & N. R. R.	989

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Dundee	Powell	U. S. B. M. L. & E. Station	711
East Louisville	Jefferson	L. & N. R. R.	460
Elkin	Clark	L. & N. R. R.	773
Estill Furnace	Estill	Foundation	1,261
Ewing	Fleming	L. & N. R. R.	903
Ewington	Montgomery	C. & O. R. R.	992
Fairdale	Jefferson	U. S. B. M.	474
Fairfield	Nelson	U. S. B. M.	715
Fair Grounds	Jefferson	U. S. B. M.	727
Farmers	Rowan	C. & O. R. R.	668
Faulconer	Boyle	B. M. on natural rock	890
Filson	Powell	U. S. B. M. L. & E. Station	667
Fisherville	Jefferson	U. S. B. M.	562
Flanagan	Clark	L. & N. R. R.	850
Ford	Clark	L. & N. R. R.	623
Forkland	Boyle	U. S. B. M.	807
Fort Estill	Madison	L. & N. R. R.	1,031
Fort Estill Jct.	Madison	L. & N. R. R.	1,036
Gap in Knob	Bullitt	U. S. B. M.	493
Garrison	Lewis	C. & O. R. R.	526
Gates	Rowan	C. & O. R. R.	819
Gethsemane	Nelson	L. & N. R. R.	458
Gilberts Creek	Lincoln	U. S. B. M.	855
Glenarvon	Clark	L. & E. R. R.	971
Glencairn	Powell	U. S. B. M. L. & E. Station	784
Glenn	Lewis	C. & O. R. R.	543
Goshen	Oldham	U. S. B. M.	699

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Gravel Switch	Marion	L. & N. R. R.	896
Gum Sulphur	Rockcastle	L. & N. R. R.	878
Hall's Gap	Lincoln	L. & N. R. R.	993
Harris	Madison	L. & N. R. R.	1,009
Harrod's Creek	Jefferson	Weather Bureau	410
Hayden	Lincoln	L. & N. R. R.	823
Hedges	Clark	C. & O. R. R.	976
Hedgeville	Boyle	U. S. B. M.	924
High Grove	Nelson	U. S. B. M.	499
Hikes Point	Jefferson	U. S. B. M.	562
Huber	Bullitt	L. & N. R. R.	458
Hyattsville	Garrard	U. S. B. M.	1,035
Indian Fields	Clark	U. S. B. M. L. & E. Station	746
Irvine	Estill	L. W. in Kentucky River	571
Jeffersontown	Jefferson	U. S. B. M.	711
Johnson	Fleming	L. & N. R. R.	898
Junction City	Boyle	Q. & C. R. R.	982
Kentucky River	Clark	L. W. at Boonesboro	538
Kentucky River	Clark	L. W. at mouth of Red River	548
Kentucky River	Estill	L. W. at Irvine	571
King's Mountain	Lincoln	Q. & C. R. R.	1,168
Knob Lick	Nelson	L. & N. R. R.	900
LaGrange	Oldham	L. & N. R. R.	841
Lancaster C. H.	Garrard	U. S. B. M.	1,032
Langford	Rockcastle	L. & N. R. R.	905
Lebanon	Marion	L. & N. R. R.	754

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Lebanon Jct.	Bullitt	L. & N. R. R.	429
L. & E. Jct.	Clark	U. S. B. M. L & E. Station	929
L. & E. Tunnel	Clark	L. & E. R. R.	1,006
Licking River	Bath	L. W. at mouth of Flat Creek	597
Licking River	Bath	L. W. at mouth of Slate Creek	623
Licking River	Bath	L. W. at mouth of Salt Creek	644
Licking River	Bath	L. W. at mouth of Beaver	676
Livingston	Rockcastle	L. & N. R. R.	858
Lombard	Powell	U. S. B. M. L. & E. Station	681
Long Run	Jefferson	U. S. B. M. at L. & N. Station	630
Longview	Jefferson	U. S. B. M.	445
Loretto	Marion	L. & N. R. R.	711
Louisville	Jefferson	L. W. above Falls	386
Louisville	Jefferson	Weather Bureau	525
Lowell	Garrard	L. & N. R. R.	799
Lyndon	Jefferson	U. S. B. M.	561
McKinney	Lincoln	Q. & C. R. R.	1,008
Manchester	Lewis	L. W. in Ohio River	451
Manchester	Lewis	C. & O. R. R.	525
Marcellus	Garrard	U. S. B. M.	915
Maretburg	Rockcastle	L. & N. R. R.	1,165
Marksbury	Garrard	U. S. B. M.	981
Mayde	Madison	L. & N. R. R.	986

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Maywood	Lincoln	L. & N. R. R.	1,015
Meadow Lawn	Jefferson	U. S. B. M.	446
Middletown	Jefferson	U. S. B. M.	722
Milledgeville	Lincoln	U. S. B. M.	1,035
Moran's Summit	Madison	L. & N. R. R.	964
Moreland	Lincoln	U. S. B. M.	1,120
Motherhead Ford	Bullitt	U. S. B. M.	435
Mt. Guthrie	Rockcastle	L. & N. R. R.	1,121
Mt. Sterling	Montgomery	C. & O. R. R.	934
Mt. Vernon	Rockcastle	L. & N. R. R.	1,113
Mt. Washington	Bullitt	U. S. B. M.	688
Mullins	Rockcastle	L. & N. R. R.	904
Nazareth	Nelson	L. & N. R. R.	693
Nelsonville	Nelson	L. & N. R. R.	434
New Haven	Nelson	L. & N. R. R.	444
New Hope	Nelson	L. & N. R. R.	488
O'Bannon	Jefferson	U. S. B. M.	765
Ohio River	Jefferson	L. W. at Louisville	386
Ohio River	Jefferson	L. W. at Bethlehem	399
Ohio River	Lewis	L. W. at Quincy	464
Okolona	Jefferson	U. S. B. M.	470
Olympia	Bath	C. & O. R. R.	751
Orell	Jefferson	L. & N. R. R.	412
Paint Lick	Garrard	L. & N. R. R.	794
Parksville	Boyle	L. & N. R. R.	1.052
Penick	Marion	L. & N. R. R.	930
Perryville	Boyle	U. S. B. M.	851

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Pewee Valley	Oldham	U. S. B. M.	784
Phillipsburg	Marion	L. & N. R. R.	704
Pine Grove	Clark	C. & O. R. R.	960
Pine Hill	Rockcastle	L. & N. R. R.	966
Pleasant Valley	Rockcastle	L. & N. R. R.	1,110
Pleasure Ridge Park	Jefferson	I C. R. R.	447
Point Leavell	Garrard	L. & N. R. R.	884
Preachersville	Lincoln	U. S. B. M.	998
Preston	Bath	C. & O. R. R.	742
Prewitt	Montgomery	C. & O. R. R.	1,054
Prospect	Jefferson	U. S. B. M.	484
Quincy	Lewis	L. W. in Ohio River	464
Quincy	Lewis	C. & O. R. R.	543
Red House	Madison	L. & N. R. R.	710
Renick	Marion	L. & N. R. R.	927
Richmond	Madison	L. & N. R. R.	926
Riley	Marion	L. & N. R. R.	914
Riverside	Clark	L. & N. R. R.	645
Riverside	Jefferson	I. C. R. R.	445
Rosslyn	Powell	U. S. B. M. L. & E. Station	668
Rowland	Lincoln	L. & N. R. R.	844
Rugless	Lewis	C. & O. R. R.	703
Salt Lick	Bath	C. & O. R. R.	656
Samuel Hill	Bullitt	U. S. B. M.	838
Samuels	Nelson	L. & N. R. R.	652
Sayres	Nelson	L. & N. R. R.	674
Seatonsville	Jefferson	U. S. B. M.	500

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Shearer	Madison	L. & N. R. R.	615
Shelby	Boyle	U. S. B. M.	991
Shelby Jct.	Jefferson	L. & N. R. R.	696
Shepherdsville	Bullitt	U. S. B. M. C. H.	446
Shively	Jefferson	U. S. B. M.	458
Silver Creek Station	Madison	L. & N. R. R.	804
Sinks	Rockcastle	L. & N. R. R.	906
Skylight	Oldham	U. S. B. M.	704
Smyrna	Jefferson	U. S. B. M	632
South Fork	Lincoln	Weather Bureau	981
South Louisville	Jefferson	L. & N. R. R.	462
South Park	Jefferson	U. S. B. M.	478
Springdale	Jefferson	U. S. B. M.	620
St. Mary	Marion	L. & N. R. R.	733
Stanford	Lincoln	U. S. B. M. C. H.	912
Stanton	Powell	U. S. B. M. L. & E. Station	662
Stine	Jefferson	L. S. R. R.	484
Strawberry	Jefferson	L. & N. R. R.	432
Sweeney	Garrard	U. S. B. M.	1,024
Tucker	Jefferson	S. R. R.	719
Upper Bruce	Lewis	C. & O. R. R.	553
Valley Station	Jefferson	U. S. B. M.	452
Vanceburg	Lewis	C. & O. R. R.	523
Virden	Powell	U. S. B. M. L. & E. Station	660
Waynesburg	Lincoln	Q. & C. R. R.	1,215
Westport	Oldham	U. S. B. M.	487
Wetwoods	Jefferson	U. S. B. M.	473

ELEVATION ABOVE SEA OF POINTS IN THE KENTUCKY KNOB COUNTIES—Continued.

Place	County	Station	Elevation
Whitefield	Bullitt	U. S. B. M.	729
White's Station	Madison	L. & N. R. R.	903
Wildie	Rockcastle	L. & N. R. R.	928
Winchester	Clark	U. S. B. M. L. & E. Station	981
Woodlawn	Jefferson	L. & N. R. R.	509
Worthington	Jefferson	U. S. B. M.	695
Wyandotte	Clark	U. S. B. M. L. & E. Station	990
Zoneton	Bullitt	U. S. B. M.	485

TABLE 3

MEAN TEMPERATURE*

Station	Length of Record Years	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Farmers	12	36.0	34.8	45.0	54.6	63.7	71.0	75.0	73.9	68.2	56.6	45.0	35.4	54.9
Berea	16	37.4	36.8	47.0	56.2	66.3	72.8	76.1	74.6	69.4	58.4	47.4	36.7	56.6
Shelby City	19	35.4	33.5	45.6	54.2	64.9	71.8	75.6	74.6	69.2	57.8	45.5	34.8	55.2
Loretto	18	37.2	34.4	45.6	55.2	65.6	72.6	76.4	75.4	70.3	58.4	46.7	36.2	56.2
Bardstown	20	35.8	34.5	46.6	55.3	67.0	74.6	78.6	77.4	71.9	59.5	46.8	36.3	57.0
Anchorage	16	34.0	32.4	44.5	54.1	65.0	71.9	76.3	74.8	69.1	56.2	44.6	34.0	54.8

*(Ref. data dealing with weather conditions based on United States Weather Bureau Reports).

TABLE 4

PROBABILITY OF KILLING FROST IN THE KNOB COUNTIES OF KENTUCKY*

Stations	Counties	Elevation, Feet	Probable Latest Dates of Killing Frost in Spring and Percentage of Risk					Actual Dates of Last Killing Frost in Spring	
			Average Date, Risk 50%	Risk 33 1/3%, or 1 Year in 3	Risk 20%, or 1 Year in 5	Risk 10%, or 1 Year in 10	Risk 5%, or 1 Year in 20.	Earliest Date on Record	Latest Date on Record
			Apr.	Apr.	Apr.				
Anchorage	Jefferson	700	18	23	26	Apl. 29	May 2	April 1, 1913	May 14, 1895
Bardstown	Nelson	637	18	23	27	May 2	May 5	March 29, 1913	May 3, 1911
Loretto	Marion	681	19	23	26	Apl. 29	May 2	April 5, 1903	May 3, 1911
**Louisville	Jefferson	525	10	14	18	Apl. 21	Apl. 25	March 25, 1878	May 14, 1895
**Mt. Sterling	Montgomery	930	15	19	22	Apl. 26	Apl. 29	March 30, 1913	May 15, 1895
**Richmond	Madison	926	15	20	23	Apl. 27	Apl. 30	March 30, 1913	May 2, 1909
Shelby City	Boyle	1087	21	26	29	May 3	May 6	April 5, 1903	May 9, 1906

*Based on "Killing Frost and Length of the Growing Season in Various Sections of Kentucky," by F. J. Walz, Ky. Agr. Exp. Station, University of Kentucky, Lexington, Ky.—Circular No. 19.

**These weather stations are not in the Knobs proper, although in counties containing the Knob Belt. Louisville is partially on Knob strata.

TABLE 5

PROBABILITY OF KILLING FROST IN THE KNOB COUNTIES OF KENTUCKY*

Stations	Probable Earliest Dates of Killing Frost in Fall, and Percentage of Risk					Actual Dates of First Killing Frost in Fall	
	Average Date, Risk 50%	Risk 33⅓%, or 1 year in 3	Risk 20%, or 1 Year in 5	Risk 10%, or 1 Year in 10	Risk 5%, or 1 Year in 20.	Earliest Date on Record	Latest Date on Record
	Oct.	Oct.	Oct.				
Anchorage	17	14	11	Oct. 8	Oct. 5	Sept. 30, 1899	Oct. 30, 1897
Bardstown	17	14	11	Oct. 7	Oct. 4	Sept. 27, 1899	Oct. 31, 1908
Loretto	14	9	5	Sept. 30	Sept. 26	Sept. 14, 1902	Oct. 30, 1897
**Louisville	22	17	14	Oct. 9	Oct. 5	Sept. 30, 1899	Nov. 14, 1882
**Mt. Sterling	19	15	12	Oct. 8	Oct. 5	Sept. 30, 1899	Oct. 31, 1908
**Richmond	20	16	13	Oct. 10	Oct. 7	Sept. 30, 1899	Nov. 2, 1911
Shelby City	15	10	6	Oct. 1	Sept. 27	Sept. 14, 1902	Oct. 30, 1897

* Based on "Killing Frost and Length of the Growing Season in Various Sections of Kentucky," by F. J. Walz, Ky. Agr. Exp. Station, University of Kentucky, Lexington, Ky.—Circular No. 19.

**These weather stations are not in the Knobs proper although in counties containing the Knob Belt. Louisville is partially in the Knob strata.

TABLE 6

LENGTH OF THE GROWING SEASON IN THE KNOB COUNTIES OF KENTUCKY*

Stations	Probable Length 4 Years in 5		Actual Lengths of Growing Season			
	Practically Sure	Range of Probability	Longest on Record and Year		Shortest on Record and Year	
	Days	Days	Days	Year	Days	Year
Anchorage	162	178 to 190	203	1913	154	1908
Bardstown	158	173 to 191	206	1913	155	1906
Loretto	154	168 to 188	201	1903	154	1902—1908
Louisville	171	183 to 207	223	1915	140	1895
Mt. Sterling	165	174 to 198	210	1908	138	1895
Richmond	166	180 to 200	206	1911	164	1909
Shelby City	151	165 to 189	202	1898—1903	152	1902

* Based on "Killing Frost and Length of the Growing Season in Various Sections of Kentucky," by F. J. Walz, Ky. Agr. Exp. Station, University of Kentucky, Lexington, Ky.—Circular No. 19.

TABLE 7

MEAN PRECIPITATION

Station	Length of Record Years	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Farmers	12	4.09	2.98	5.09	4.01	3.75	4.44	5.26	4.93	3.00	3.30	2.57	3.79	47.21
Berea	16	4.51	3.11	4.77	3.60	4.01	4.81	4.99	4.75	2.73	2.98	2.84	4.54	47.64
Shelby City	24	4.47	3.66	4.98	3.66	3.88	3.75	4.34	3.48	3.06	2.25	3.14	4.39	45.06
Loretto	20	4.52	2.97	4.31	3.49	3.97	4.48	4.20	3.66	2.92	2.44	2.96	4.28	44.20
Bardstown	24	4.58	3.98	4.39	4.00	3.67	4.22	4.41	3.89	2.81	2.40	3.31	4.71	46.37
Anchorage	19	3.77	3.15	4.03	3.66	3.65	3.90	4.81	3.60	2.67	2.66	2.99	3.95	42.84

TABLE 8

1920 LAND TABLES*

County	Area of County in Acres	Improved Land in Farm Acres	Per Cent of Land Surface Improved	Woodland in Farms, Acres	Other Unimproved Land in Farms Acres	Unimproved Land Not in Farms, Acres	Total Unimproved Land, Acres	Per Cent of Land Surface Unimproved
Bath	172,800	91,459	52.9	26,718	12,061	42,562	81,341	47.0
Boyle	119,040	87,140	73.2	21,360	2,773	7,767	31,900	26.8
Bullitt	197,120	93,640	47.5	46,364	20,302	36,814	103,480	52.5
Clark	169,600	129,732	76.4	10,369	14,467	15,032	39,868	23.6
Estill	162,560	61,069	37.5	70,972	7,119	23,400	101,491	62.5
Fleming	208,000	156,270	75.1	38,223	9,685	3,822	51,730	24.9
Garrard	151,680	111,667	73.6	12,793	4,574	22,646	40,013	26.4
Jefferson	247,680	135,903	54.8	22,138	23,337	66,302	111,777	45.2
Lewis	314,240	101,689	32.3	120,006	20,470	72,075	212,551	67.7
Lincoln	216,320	125,769	58.1	39,042	3,149	48,360	90,551	41.9
Madison	285,440	222,050	77.7	22,470	10,931	29,989	63,390	22.3
Marion	220,800	123,665	56.0	56,490	7,705	32,940	97,135	44.0
Montgomery	126,720	96,776	76.3	15,654	5,154	9,136	29,944	23.7
Nelson	263,040	158,652	60.3	58,336	11,944	34,108	104,388	39.7
Oldham	115,200	81,048	70.3	18,200	15,546	406	34,152	29.7
Powell	115,840	31,659	27.3	53,125	5,483	25,573	84,181	72.7
Rockcastle	198,400	87,011	43.8	78,872	7,341	25,176	111,389	56.2
Rowan	174,080	41,682	23.9	81,609	8,991	41,798	132,398	76.1
The Knobs	3,458,560	1,936,881	56.0	792,741	191,032	537,906	1,521,679	44.0
The State	25,715,840	13,975,746	54.3	6,018,280	1,618,746	4,103,068	11,740,094	45.7

*Statistics, unless otherwise noted, are based on reports of the U. S. Census.)

TABLE 9

NUMBER OF ACRES OF WOODLANDS PER SQUARE MILE OF LAND SURFACE

County	1910	1920
Bath	88.6	98.9
Boyle	114.9	114.8
Bullitt	205.3	150.5
Clark	33.7	39.1
Estill	280.7	279.4
Fleming	117.4	117.6
Garrard	52.5	53.9
Jefferson	67.7	57.2
Lewis	199.2	244.4
Lincoln	162.7	115.5
Madison	72.4	50.3
Marion	156.3	163.7
Montgomery	110.7	79.0
Nelson	167.1	141.9
Oldham	119.6	101.1
Powell	386.8	293.5
Rockcastle	269.4	254.4
Rowan	310.4	300.0
The Knobs	158.1	146.6
The State	173.0	149.7

TABLE 10

NUMBER OF FARMS

County	Number of Farms			Increase (+) or Decrease (—) in number of Farms	
	1900	1910	1920	1900–1910	1910–1920
Bath	2027	2017	2005	—10	—12
Boyle	875	1135	1394	+260	+259
Bullitt	1173	1213	1259	+40	+46
Clark	1373	1516	1656	+143	+140
Estill	1665	1881	1832	+216	—49
Fleming	2527	2933	3123	+406	+190
Garrard	1306	1852	1929	+546	+77
Jefferson	2827	3093	2826	+266	—267
Lewis	2476	2852	2777	+376	—75
Lincoln	1945	2510	2323	+565	—187
Madison	2741	3770	3558	+1029	—212
Marion	1590	1858	1970	+268	—112
Montgomery	1222	1369	1475	+147	+106
Nelson	1716	1752	1869	+36	+117
Oldham	811	873	1086	+62	+213
Powell	895	998	844	+103	—154
Rockcastle	1747	2160	2302	+413	+142
Rowan	1112	1179	1303	+67	+124
The Knobs	30028	34961	35531	+4933	+570
The State	234667	259185	270626	+24518	+11441

TABLE 11

AVERAGE SIZE OF FARMS IN ACRES

County	Average Number of Acres Per Farm		
	1900	1910	1920
Bath	74.6	71.0	65.0
Boyle	124.3	97.4	79.8
Bullitt	143.0	129.5	127.3
Clark	107.0	98.9	93.3
Estill	82.9	75.9	76.0
Fleming	80.9	72.8	65.4
Garrard	99.1	69.0	66.9
Jefferson	73.8	63.6	64.2
Lewis	88.5	85.8	87.2
Lincoln	94.4	75.8	72.3
Madison	97.4	69.1	71.8
Marion	150.0	105.5	95.4
Montgomery	107.6	85.2	79.7
Nelson	130.8	130.5	122.5
Oldham	137.4	121.7	105 7
Powell	119.6	112.4	107.0
Rockcastle	93.9	79.1	75.2
Rowan	100.1	108.7	101.5
The Knobs	100.5	85.7	82.2
The State	93.6	85.6	79.9

TABLE 12

IMPROVED LAND IN FARMS—1900-1920

Number of Acres Per Farm

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1900	61.2	91.5	81.0	90.6	38.0	64.3	86.9	59.1	41.0	65.8	83.6	88.4	84.0	89.6	109.2	40.9	42.7	51.4	67.8	58.5
1910	56.1	76.1	68.2	90.1	36.6	56.1	60.2	48.8	38.1	52.8	58.7	71.5	68.1	86.2	91.5	38.1	38.6	36.1	57.1	55.4
1920	45.6	62.5	74.4	78.3	33.3	50.0	57.9	48.1	36.6	54.1	62.4	62.8	65.6	84.9	74.6	37.5	37.8	32.0	54.5	51.6
PER CENT OF FARM LAND IMPROVED																				
1900	82.1	73.6	56.6	84.6	45.8	79.5	87.7	80.1	46.3	69.6	85.7	58.9	78.0	68.5	79.4	34.2	45.4	51.3	67.6	62.5
1910	79.0	78.2	52.7	91.1	48.2	77.0	87.2	76.8	44.4	69.6	84.9	67.8	79.9	66.0	75.2	33.9	48.8	33.2	66.6	64.7
1920	70.2	78.3	58.4	83.9	43.9	76.5	86.5	74.9	42.0	74.9	86.9	65.8	82.3	69.3	70.6	35.1	50.2	31.5	66.3	64.7

TABLE 13

LAND VALUES—ASSESSED VALUES PER ACRE—1900-1920

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1900	$21.32	$33.64	$ 9.82	$42.18	$ 5.43	$18.75	$21.91	$67.02	$ 6.60	$18.51	$23.20	$11.23	$34.28	$13.48	$20.66	$5.18	$5.54	$3.24	$20.37	$13.24
1910	38.98	55.83	13.66	69.40	10.81	32.75	50.84	90.40	9.71	32.00	41.62	23.29	56.77	20.76	30.12	15.89	7.45	4.39	33.10	21.83
1920	84.75	121.36	29.88	147.82	20.80	67.43	121.18	121.19	18.20	70.99	95.09	42.49	140.26	55.23	73.33	18.30	15.51	10.10	67.89	48.62

PER CENT OF INCREASE IN LAND VALUES BY DECADES—1900-1920

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1900 to 1910	82	65	39	64	99	75	132	35	47	73	79	107	66	54	46	207	34	35	62	64
1910 to 1920	117	117	118	113	92	105	138	34	87	122	128	82	147	166	143	15	108	130	105	122

TABLE 14

FARM VALUATION AND GROSS INCOME

County	Average Acreage Per Farm		Average Improved Acreage Per Farm		Average Assessed Value of all Property per Farm		Average Gross Crop Return per Farm	
	1910	1920	1910	1920	1910	1920	1909	1919
Bath	71.0	65.0	56.1	45.6	$4,193	$7,311	$681.05	$1,186.12
Boyle	97.4	79.8	76.1	62 5	7,876	13,185	932.46	2,121.83
Bullitt	129.5	127.3	68.2	74.4	3,172	6,443	560.11	1,511.75
Clark	98.9	93 3	90.1	78.3	9,485	17,523	993.89	2,060.48
Estill	75.9	76.0	36.6	33.3	1,389	2,446	306.56	812.37
Fleming	72.8	65.4	56.1	50.0	3,689	6,160	632.96	982.99
Garrard	69.0	66.9	60.2	57.9	5,054	10,443	691.62	2,567.82
Jefferson	63.6	64.2	48 8	48.1	8,479	11,792	871.89	2,518.96
Lewis	85.8	87.2	38.1	36.6	1,542	2,754	440.99	938.54
Lincoln	75.8	72.3	52 8	54.1	3.752	7,346	521.10	1,428.57
Madison	69.1	71.8	58.7	62.4	4,191	9,193	552.52	1,531.27
Marion	105.5	95.4	71.5	62.8	4,105	5,817	651.50	1,278.54
Montgomery	85.2	79.7	68.1	65.6	7,063	14,471	863.22	2,028.56
Nelson	130.5	122.5	86.2	84.9	4,705	9,924	695.94	1,685.99
Oldham	121.7	105.7	91.5	74.6	6,127	11,736	832.82	2,220.84
Powell	112.4	107.0	38.1	37.5	2,375	2,998	307.19	747.68
Rockcastle	79.1	75.2	38.6	37.8	1,134	2,057	265.83	747.67
Rowan	108.7	101.5	36.1	32.0	975	1,888	249.88	643.84
The Knobs	85.7	82.2	57.1	54.5	4,400	7,971	606.15	1,489.39
The State	85.6	79.9	55.4	51.6	2,986	5,587	536.19	1,288.32

TABLE 15

CORN PRODUCTION

Number of Bushels of Corn Per Square Mile of Land Surface

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1909	2,694	4,132	1,840	3,180	2,159	3,130	4,001	2,447	1,057	2,736	3,451	2,316	2,957	2,666	2,678	1,431	1,387	899	2,451	2,074
1919	1,637	3,511	1,598	2,527	1,938	1,734	4,190	2,010	995	2,474	3,571	1,827	2,768	1,791	2,403	1,321	1,766	960	2,091	1,779

Number of Bushels of Corn Per Square Mile of Improved Land

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1909	4,116	5,698	4,388	4,394	5,098	3,956	5,447	4,012	3,059	4,470	4,450	3,849	4,022	4,646	3,866	4,363	3.301	3,685	4,242	3,716
1919	3,093	4,799	3,366	3,304	5,160	2,309	5,695	3,664	3,078	4,255	4,591	3,280	3,625	2,971	3,416	4.843	4,029	4,011	3,734	3,275

TABLE 16

WHEAT PRODUCTION

Number of Bushels of Wheat Per Square Mile of Land Surface

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1909	123	1,058	113	289	1.5	280	524	382	26	403	189	140	68	268	246	2.0	85	3.7	219	217
1919	217	1,251	212	393	10.0	372	534	593	85	435	316	263	275	520	630	2.4	99	68.2	332	258

Number of Bushels of Wheat Per Square Mile of Improved Land

	Bath	Boyle	Bullitt	Clark	Estill	Fleming	Garrard	Jefferson	Lewis	Lincoln	Madison	Marion	Montgomery	Nelson	Oldham	Powell	Rockcastle	Rowan	The Knobs	The State
1909	188	1,459	269	359	3.5	354	714	626	76	659	244	233	92	468	355	6.2	203	15.4	379	389
1919	410	1,710	446	515	26.8	496	726	1,081	264	748	406	469	360	864	896	8.8	226	285.1	592	475

TABLE 17

PRODUCTION OF CEREALS PER SQUARE MILE OF LAND AREA—1919

County	Corn		Wheat		Oats		Rye		Barley		Buckwheat	
	Acres Planted	Bushels Produced	Acres Planted	Bushels Produced	Acres Planted	Bushels Produced	Acres Planted	Bushels Produced	Acres Planted	Bushels Produced	Acres Planted	Bushels Produced
Bath	79.9	1637.3	14.6	217.2	6.8	83.5	1.6	13.6	.029	.29	.037	.185
Boyle	99.7	3511.7	69.5	1251.5	2.8	53.2	1.7	18.4	.806	15.66	....	....
Bullitt	68.5	1598.8	16.4	212.0	4.9	67.9	.2	1.6	.038	.58	....	....
Clark	75.0	2527.5	28.3	393.9	2.3	34.8	1.2	15.2	.596	10.78	....	....
Estill	74.0	1938.1	1.2	10.0	2.6	30.2	.1	.4	....	....	....	....
Fleming	81.9	1734.9	28.9	372.9	9.0	114.4	1.4	13.3	.181	3.30	.009	.049
Garrard	115.3	4190.8	40.8	534.9	5.9	92.0	3.8	31.7	.210	2.02	.088	.886
Jefferson	71.3	2010.0	36.0	593.2	4.7	85.0	1.8	15.4	.077	.89	.069	.863
Lewis	48.7	995.7	7.1	85.4	5.1	83.2	.2	2.5	.024	.50	.008	.075
Lincoln	81.6	2474.0	33.0	435.3	9.1	145.2	.4	4.8	.446	9.79	1.615	18.878
Madison	107.8	3571.5	23.6	316.2	3.7	65.7	1.9	19.0	.179	4.06	.044	.493
Marion	75.2	1837.0	21.5	263.1	9.7	143.3	1.4	12.2	.034	.34	.017	.231
Montgomery	80.6	2768.6	20.7	275.5	7.9	140.8	1.7	14.2	.005	.10	.020	.116
Nelson	82.8	1791.5	41.5	520.9	11.6	167.9	1.3	13.0	.194	2.15	.036	.486
Oldham	78.5	2403.1	33.9	630.7	15.5	254.5	2.0	14.8	.066	.57	....	....
Powell	56.3	1321.8	.3	2.4	2.5	20.3	.09	.7	.110	.69	.005	.022
Rockcastle	86.1	1766.4	12.1	99.2	12.8	142.9	.1	1.2	.032	.70	.729	6.090
Rowan	54.0	960.1	7.5	68.2	10.4	114.3	.05	.3	.025	.22	.180	2.209
The Knobs	78.2	2091.3	23.8	332.0	7.1	102.3	1.17	10.4	.157	2.74	.172	1.858
The State	80.8	1779.9	20.9	258.2	5.7	69.4	.68	5.9	.139	2.97	.189	1.825

Total Cereals per square mile of land area. Knobs—110.7 acres—2540.8 bushels. State—108.4 acres—2118.9 bushels.

TABLE 18

HAY AND FORAGE PER SQUARE MILE OF LAND AREA—19[illegible]9

County	Total		All Tame or Cultivated Grasses		Timothy Alone		Timothy and Clover Mixed		Clover Alone		Alfalfa		Other Tame or Cultivated Grasses	
	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons
Bath	46.2	48.9	15.2	13.9	7.3	6.9	5.9	5.2	.9	.8	.03	.03	.9	.8
Boyle	55.2	83.6	29.8	36.0	15.8	18.0	8.8	10.1	4.0	5.6	.66	1.13	.5	1.0
Bullitt	71.3	84.0	23.8	23.9	7.6	7.2	10.1	10.3	3.0	3.6	.62	1.02	2.3	1.7
Clark	76.1	108.6	23.0	31.3	13.6	20.3	5.1	5.0	3.5	5.2	.31	.32	.3	.2
Estill	70.7	71.2	12.7	11.3	3.5	3.0	5.2	5.2	1.1	.9	.13	.10	2.6	2.0
Fleming	77.7	64.3	30.1	27.2	10.2	10.5	16.9	14.0	1.8	1.6	.57	.76	0.5	.2
Garrard	43.6	55.6	16.9	17.4	6.1	6.2	8.0	8.2	2.3	2.2	....	....	.4	.7
Jefferson	79.3	122.3	38.1	40.1	10.9	11.5	10.7	10.8	7.9	8.4	1.65	3.76	6.8	5.5
Lewis	47.4	42.7	13.8	12.5	6.1	5.3	4.5	4.6	.7	.6	.54	.71	1.8	1.2
Lincoln	62.4	64.9	30.4	32.1	12.1	11.6	11.9	13.4	2.6	2.7	.30	.52	3.3	3.7
Madison	52.3	61.3	15.4	20.1	5.7	5.6	6.7	11.7	1.6	1.4	.28	.57	.9	.6
Marion	45.6	47.4	27.9	31.5	15.1	20.2	10.4	9.1	1.7	1.6	.10	.14	.5	.3
Montgomery	71.9	70.2	28.8	26.9	10.3	9.7	11.8	11.0	2.1	2.4	.26	.72	4.2	2.8
Nelson	44.9	58.0	28.7	29.9	13.3	13.2	9.8	9.5	3.9	4.1	.81	1.62	.8	1.4
Oldham	98.5	163.6	52.0	63.2	5.5	5.1	10.4	16.8	21.8	27.4	1.71	2.91	12.6	10.8
Powell	20.8	32.6	6.4	8.9	3.2	5.7	1.1	1.0	.4	.6	.24	.16	1.2	1.3
Rockcastle	72.1	56.8	14.5	12.7	2.0	1.8	5.1	4.9	2.2	1.9	.02	.02	5.0	3.9
Rowan	26.3	13.5	6.5	4.4	1.7	1.2	2.7	1.8	.3	.3	....	....	1.7	1.0
The Knobs	58.5	67.3	22.7	24.1	8.5	9.1	8.2	8.5	3.1	3.4	.47	.84	2.4	2.0
The State	51.8	52.8	22.8	23.6	5.9	6.0	6.3	6.9	2.6	3.0	1.39	2.02	6.4	5.6

TABLE 19

TOBACCO

County	Acres Planted		Pounds Produced		Pounds Per Acre	
	1909	1919	1909	1919	1909	1919
Bath	5,562	6,352	5,557,379	4,641,870	999	730
Boyle	1,474	3,460	1,590,668	3,520,305	1,079	1,017
Bullitt	845	1,515	660,531	1,084.317	781	715
Clark	4,418	5,706	5,152,813	5,122,635	1,166	897
Estill	295	412	234,099	268,761	793	652
Fleming	7,394	6,925	7,573,662	5,233,459	1,024	755
Garrard	3,461	11,996	3,563,086	11,073.655	1,029	923
Jefferson	269	1,167	263,200	917,905	978	786
Lewis	5,949	5,281	4,682,548	3,824,465	787	724
Lincoln	2,792	3,630	2,807,458	3,394,716	1,005	935
Madison	5,668	7,246	6,068,924	6,464,132	1,070	892
Marion	3,033	3,555	3,071,025	2,768,094	1,012	778
Montgomery	4,187	6.411	4,733,743	6,187,835	1,130	965
Nelson	2,094	3,948	1,830,991	2,692,476	874	681
Oldham	1,515	1,968	1,216,170	1,603,261	802	814
Powell	168	216	107,534	150,494	640	696
Rockcastle	179	538	118,593	359,909	662	668
Rowan	127	564	76,419	252,922	601	448
The Knobs	40,430	70,890	49,308,843	59,561,211	997	840
The State	469,795	640,241	398,482,301	511,872,486	848	799

TABLE 20

LIVE STOCK ON FARMS AND RANGES PER SQUARE MILE OF LAND AREA

County	Horses		Mules		Asses and Burros		Cattle		Sheep		Goats		Swine	
	1910	1920	1910	1920	1910	1920	1910	1920	1910	1920	1910	1920	1910	1920
Bath	16.7	13.8	7.7	6.2	.15	.07	39.2	32.2	47.3	10.0	.12	.27	38.2	33.5
Boyle	16.6	13.4	7.8	7.9	.73	.25	42.7	41.0	82.4	29.4	.34	.52	59.5	65.1
Bullitt	9.8	9.0	3.8	5.1	.06	.12	17.4	24.0	18.6	10.8	.80	.43	32.4	39.7
Clark	16.2	12.4	7.7	8.7	.18	.05	62.0	53.5	139.2	69.5	.21	.10	60.5	45.5
Estill	8.2	7.3	3.9	6.3	.07	.08	25.3	26.2	9.5	4.6	.18	.06	31.5	28.1
Fleming	22.3	18.5	3.7	4.4	.53	.21	38.5	36.4	56.7	29.6	.10	.27	52.9	39.0
Garrard	18.5	15.3	7.5	10.0	.14	.07	40.2	39.0	65.6	24.8	.01	0.45	56.2	65.8
Jefferson	18.2	11.9	7.1	8.8	.08	.01	28.7	35.7	19.1	11.8	.32	.16	35.4	49.1
Lewis	7.6	7.7	1.4	2.7	.02	.01	15.7	18.1	6.6	2.7	.11	.004	10.5	14.1
Lincoln	15.5	12.8	6.2	7.1	.32	.23	37.7	31.7	66.1	27.8	.87	.52	34.5	39.5
Madison	17.8	14.0	6.3	9.0	.25	.12	56.3	52.7	41.8	13.4	.21	.16	49.4	57.2
Marion	15.6	11.4	7.0	6.8	.53	.25	25.8	27.1	55.2	21.0	.14	.46	40.2	40.4
Montgomery	19.7	15.0	5.8	7.6	.32	.05	68.3	54.1	75.6	28.4	.36	.09	53.4	37.2
Nelson	13.5	10.8	4.6	6.7	.13	.14	28.4	30.7	61.0	31.4	.53	.09	45.1	56.1
Oldham	13.6	12.1	6.4	7.6	.07	.07	31.5	47.2	96.9	52.6	.08	.05	53.6	64.9
Powell	6.2	5.2	1.9	4.7	.07	.03	19.7	21.3	6.4	2.2	.005	.00	26.5	22.6
Rockcastle	7.7	7.9	3.5	7.1	.04	.11	19.4	22.4	14.8	11.2	.34	.38	20.7	26.8
Rowan	3.5	4.2	2.1	4.6	.03	.04	12.6	17.3	5.1	3.0	.56	.11	9.9	13.7
The Knobs	13.7	11.2	5.1	6.6	.20	.11	33.0	33.2	44.8	20.0	.31	.22	37.9	40.3
The State	11.0	9.5	5.6	7.2	.116	.071	24.9	27.2	33.9	17.6	.74	.87	37.1	37.4

TABLE 21

SHEEP SHORN AND WOOL PRODUCED PER SQUARE MILE OF LAND AREA

County	Number Sheep Shorn		Pounds Wool Produced
	1909	1919	1919
Bath	15.8	6.8	33.5
Boyle	23.6	19.5	83.6
Bullitt	7.4	7.0	31.1
Clark	68.9	52.6	253.9
Estill	3.5	3.4	15.2
Fleming	25.0	22.7	102.3
Garrard	17.9	14.9	68.3
Jefferson	7.7	8.2	43.4
Lewis	2.9	1.9	8.9
Lincoln	22.4	19.0	90.9
Madison	11.6	8.9	44.3
Marion	20.1	13.2	56.4
Montgomery	27.9	23.3	113.4
Nelson	24.0	15.9	70.6
Oldham	41.6	43.6	223.7
Powell	1.9	1.0	4.4
Rockcastle	8.4	9.2	37.0
Rowan	2.4	1.8	8.9
The Knobs	17.2	13.9	65.2
The State	15.6	13.6	63.9

TABLE 22

POULTRY AND EGGS PER SQUARE MILE OF LAND AREA

County	Number of Poultry		Dozens Eggs Produced		Dozens Eggs Sold	
	1910	1920	1909	1919	1909	1919
Bath	343.6	357.1	1,472.4	1,173.1	829.3	788.5
Boyle	289.0	364.1	1,364.5	1,258.5	828.4	807.4
Bullitt	171.1	238 6	771.6	656.1	483.8	453.8
Clark	339.7	379.1	1,276.9	1,297.0	816.4	702.7
Estill	228.0	289.7	1,296.5	1,250.5	909.5	927.7
Fleming	406.5	442.7	1,887.0	1,665.4	1,284.7	1,162.2
Garrard	399.6	533.6	2,083.8	2,018.1	1,300.9	1,286.5
Jefferson	299.3	319.9	1,494.9	1,056.2	615.0	519.6
Lewis	173.1	201.7	945.0	786.2	681.8	586.3
Lincoln	264.5	310.0	949.1	1,272.5	609.6	975.6
Madison	379.5	469.1	1,798.0	1,687.3	1,300.0	1,249.9
Marion	211.8	277.0	907.9	1,126.2	477.9	683.4
Montgomery	328.3	396.7	1,265.6	1,350.1	665.2	701.3
Nelson	238.9	280.5	981.7	960.1	523.8	632.6
Oldham	246.6	310.7	1,096.4	1,020.2	615.1	581.6
Powell	142.4	182.5	557.3	654.1	373.6	349.8
Rockcastle	195.2	300.3	768.7	1,218.4	555.0	878.8
Rowan	99.8	155.4	461.0	575.6	215.4	358.8
The Knobs	264.2	320.6	1,195.1	1,165.4	736.4	769.1
The State	218.1	274.2	1,007.0	1,009.8	615.8	637.9

Table 23

ACADEMIES, NORMAL SCHOOLS, AND COLLEGES LOCATED IN THE KNOB BELT

Name	Town	County
Berea College	Berea.	Madison.
Berea Normal School	Berea.	Madison.
Berea Academy	Berea.	Madison.
Berea Junior High School	Berea.	Madison.
Berea Foundation	Berea.	Madison.
Eckstein Norton University (industrial and trade school)	Cane Spring.	Bullitt.
Funk Seminary	LaGrange.	Oldham
Gethsemane College (R. C.)	Gethsemane	Nelson
Loretta Academy (R. C.	Loretto	Marion
Nazareth Academy (R. C.)	Nazareth	Nelson
St. Augustine's Academy	Lebanon	Marion
St. Joseph's College (R. C.)	Bardstown	Nelson

Numerous academies and colleges are located within the Knob Counties but not on Knob strata. For example, Centre College, Boyle County, and Eastern Kentucky State Normal School, Richmond, Madison County.

TENANTS

TABLE 24

County	Number of Farms Worked by Tenants			Per Cent of all Farms Worked by Tenants.	Assessed Value of Land Per Acre.
	1900	1910	1920	1920	1920
Bath	877	856	791	39.5%	$84.75
Boyle	221	308	544	39.0%	121.36
Bullitt	315	261	325	25.8%	29.88
Clark	402	573	703	42.5%	147.82
Estill	502	568	508	27.7%	20.80
Fleming	722	1,039	1,301	41.7%	67.43
Garrard	329	626	660	34.2%	121.18
Jefferson	1,013	943	830	29.4%	121.19
Lewis	678	845	874	31.5%	18.20
Lincoln	402	619	575	24.8%	70.99
Madison	694	1,437	1,274	35.8%	95.09
Marion	359	498	573	29.1%	42.49
Montgomery	384	496	480	32.5%	140.26
Nelson	382	352	392	21.0%	55.23
Oldham	230	265	323	29.7%	73.33
Powell	259	274	182	21.6%	18.30
Rockcastle	552	672	617	26.8%	15.51
Rowan	275	281	244	18.7%	10.10
The Knobs	8,596	10,913	11,196	31.5%	67.89
The State	77,065	87,860	90,330	33.4%	48.62

TABLE 25

RAILROAD STATISTICS FOR 1915 and 1921 FROM 21st AND 24th BIENNIAL REPORT OF THE KENTUCKY STATE DEPARTMENT OF AGRICULTURE

Counties	L. & N.	C. & O.	C. N. O. & T. P. (Part of Southern R. R. System.)	Southern	L. H. & St. L.	Ky. T. & T. Co.	C. F. & S. E.	B. & O. S. W.	C. I. & L.	I. C.	L. & I.	L. & S. Ind. T. Co.	Penn. Terminal	Mt. Central	Morehead & N. F.	Total Mileage 1915	Total Mileage 1921
Bath	....	15.86														15.86	11.
Boyle	15.36		10.42	2.												27.78	27.78
Bullitt	29.69				4.50											34.19	31.
Clark	38.02	18.58				1.14										57.74	57.74
Estill	18.99															18.99	30.
Fleming	8.92						5.60									14.52	14.52
Garrard	14.20															14.20	14.20
Jefferson	43.83			21.38	11.50			.92	1.12	20.55	69.49	.134	9.72			182.21	182.
Lewis	....	56.38														56.38	56.
Lincoln	29.90		13.83													40.73	60.
Madison	66.95															66.95	67.
Marion	40.86															40.86	41.
Montgomery	....	26.22														26.22	26.
Nelson	54.62															54.62	39.
Oldham	16.44										10.93					27.37	40.
Powell	23.88													3.		26.88	27.
Rockcastle	39.61															39.61	39.
Rowan	....	16.73													14.50	31.23	31.
Totals	441.27	133.77	24.25	23.38	16.00	1.14	5.60	.92	1.12	20.55	80.42	.134	9.72	3.	14.50	776.34	794.24

TABLE 26

TOTAL AND RURAL POPULATION PER SQUARE MILE OF LAND AREA

County	Total Population			Rural Population		
	1900	1910	1920	1900	1910	1920
Bath	54 5	51.8	44.4	54.5	51.8	44.4
Boyle	74.2	78.8	80.6	51.2	49.7	53.2
Bullitt	31.1	30.8	30.2	31.1	30.8	30.2
Clark	62 9	67.8	67.5	40.4	40.8	36.1
Estill	45.9	48.3	61.2	45.9	48.3	50.6
Fleming	52 5	49.4	48.0	52.5	49.4	48.0
Garrard	50.8	50.1	52.7	50.8	50.1	52.7
Jefferson	600.9	679.3	739.9	71.8	100.7	114.4
Lewis	36.4	34.3	32.2	36.4	34.3	32.2
Lincoln	50.4	52.9	48.7	50.4	52.9	48.7
Madison	57.4	60.4	58.9	46.9	48.4	46.3
Marion	47 2	47.3	45.0	38.3	38.4	35.6
Montgomery	64.8	64.9	61.8	46.8	45.1	41.6
Nelson	40.3	40.9	39.2	40.3	40.9	39.2
Oldham	39 3	40.2	42.7	39.3	40.2	42.7
Powell	35.5	34.6	37.2	35.5	34.6	37.2
Rockcastle	40.0	46.6	49.6	40.0	46.6	49.6
Rowan	30 4	34.6	34.8	30.4	34.6	34.8
The Knobs	86.7	93.3	97.3	44.8	47.3	47.1
The State	53.4	56.9	60.1	41.7	43.1	44.3

TABLE 27
POPULATION

County	Native White				Foreign-Born White				Negro			
	Number		Per Cent		Number		Per Cent		Number		Per Cent	
	1910	1920	1910	1920	1910	1920	1910	1920	1910	1920	1910	1920
Bath	12,628	10,976	90.3%	91.5%	24	12	0.2%	0.1%	1,336	1,008	9.6%	8.4%
Boyle	10,372	11,704	70.7	78.0	143	104	1.0	0.7	4,153	3,190	28.3	21.3
Bullitt	8,734	8,838	92.1	94.8	74	48	0.8	0.5	679	442	7.2	4.7
Clark	13,443	14,130	74.7	78.9	76	79	0.4	0.4	4,462	3,691	24.8	20.6
Estill	12,164	15,352	99.1	98.6	3	13	(1)	0.1	106	204	0.9	1.3
Fleming	14,997	14,601	93.3	93.5	42	32	0.3	0.2	1,027	981	6.4	6.3
Garrard	9,593	10,581	80.7	84.6	17	8	0.1	0.1	2,284	1,914	19.2	15.3
Jefferson	197,876	228,165	75.3	79.7	19,233	13,721	7.3	4.8	45,794	44,448	17.4	15.5
Lewis	16,655	15,671	98.6	99.0	91	70	0.5	0.4	141	88	0.8	0.6
Lincoln	14,616	14,104	81.7	85.6	326	186	1.8	1.1	2,955	2,191	16.5	13.3
Madison	21,150	21,319	78.5	81.1	98	54	0.4	0.2	5,698	4,910	21.1	18.7
Marion	13,970	13,734	85.5	88.5	94	92	0.6	0.6	2,266	1,701	13.9	11.0
Montgomery	9,588	9,686	74.5	79.1	86	42	0.7	0.3	3,192	2,517	24.8	20.6
Nelson	13,719	13,942	81.5	86.4	176	126	1.0	0.8	2,935	2,069	17.4	12.8
Oldham	6,052	6,578	83.5	85.6	118	87	1.6	1.1	1,078	1,024	14.9	13.3
Powell	5,928	6,633	94.6	98.3	3	1	(1)	(1)	337	111	5.4	1.6
Rockcastle	14,330	15,329	99.0	99.5	18	7	0.1	(1)	125	70	0.9	0 5
Rowan	9,367	9,432	99.2	99.6	12	13	0.1	0.1	59	22	0.6	0.2
The Knobs	405,182	440,775	80.3	83.7	20,634	14,695	4.0	2.7	78,627	70,581	15.5	13.4
The State	1,987,898	2,149,780	86.8	89.0	40,053	30,780	1.7	1.3	261,656	235,938	11.4	9.8

(1) Less than one-tenth of 1 per cent.

%=Per cent of total population for that year.

TABLE 28

WEALTH OF KNOB COUNTIES—1920*

County	Total Taxable Wealth.	Taxable Wealth Per Square Mile of Land Area.	Taxable Wealth Per Capita.
Bath	$12,628,493	$46,772	$1,052.72
Boyle	19,576,796	105,251	1,305.29
Bullitt	6,134,256	19,916	657.61
Clark	26,715,966	100,814	1,492.42
Estill	4,724,596	18,600	303.46
Fleming	13,210,461	40,647	846.06
Garrard	14,766,066	62,304	1,181.00
Jefferson	420,255,047	1,085,930	1,467.52
Lewis	4,914,670	10,009	310.48
Lincoln	12,633,420	37,376	766.54
Madison	25,794,390	57,834	981.37
Marion	10,690,064	30,985	688.48
Montgomery	14,570,157	73,586	1,189.88
Nelson	15,178,953	36,931	938.53
Oldham	9,255,231	51,417	1,203.69
Powell	2,207,327	12,195	327.25
Rockcastle	3,258,172	10,510	211.48
Rowan	2,811,148	10,335	296.94
The Knobs	619,325,213	114,604	1,177.14
The State	2,438,612,449	60,690	1,009.09

*Statistics based on the Fifth Biennial Report of Department of State Roads and Highways, Kentucky.

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